# ASTRO-THEOLOGY:

OR, A

DEMONSTRATION

OF THE

BEING and ATTRIBUTES

OF

GOD,

FROM A

SURVEY of the HEAVENS.

Illuſtrated with COPPER-PLATES.

By W. DERHAM, Canon of Windſor,
Rector of Upminſter, in Eſſex, and F. R. S.

A NEW EDITION.

EDINBURGH:
Printed by J. GRAY,
For JOHN WOOD Bookſeller.
MDCCLXXV.

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To His Royal Highness

# GEORGE,

Prince of WALES, Prince Electoral
of *Brunſwick Lunenburg*, etc.

Duke of *Cornwall* and *Rothſay*, Duke and Marquis of *Cambridge*, Earl of *Cheſter*, *Milford-Haven*, and *Carreck*, Viſcount *North-Allerton*, Baron of *Tewkſbury* and *Renfrew*, Lord of the Iſlands, and Stewart of *Scotland*, and Knight of the moſt noble Order of the Garter.

GREAT SIR,

YOUR ROYAL HIGHNESS having done me ſo great an honour as to take this Book under your patronage, with great humility and thankfulneſs I lay it at your feet; not doubting but that (whatever my performance is) the ſubject will be acceptable, it being a vindication of the exiſtence and attributes of that infinite BEING, to whom your Royal Highneſs hath no leſs piouſly than juſtly aſcribed your great Royal Father's and your family's peaceable acceſſion to the crown, and dignity of theſe realms.

THAT the Bleſſings of the ſame moſt merciful BEING may be perpetuated to your Royal Highneſs, and all yours, is the hearty prayer of,

Moſt illuſtrious SIR,

Your *Royal Highneſs's*

moſt humble obedient Servant,

W. DERHAM.

# PREFACE.

NOtwithſtanding that a book is more complete and valuable by additions and amendments, yet, I think, that many and great additions are an hardſhip and injuſtice to the purchaſers of a former edition; and therefore I have in this, and the foregoing editions, avoided it as much as well I could, although ſome of my learned friends would have perſuaded me to it, and alſo contributed their obſervations.

But yet from what I have ſaid in the preliminary diſc. p. iii. it will, I doubt not, be expected, that I ſhould give ſome account of the obſervations, which the long and good glaſſes in my hands have afforded me ſince the laſt edition of this book.

But I have little to boaſt of here, having (beſides the old former complaint of the want of a long pole to manage Mr Huygens's glaſs with) many great hindrances in my obſervations, partly by a very dangerous fit of ſickneſs, which hung long about me; and partly by my neceſſary affairs calling me to matters of another nature. But ſome of the moſt conſiderable of my obſervations were theſe.

1. Viewing Venus with Mr Huygens's glaſs

divers nights, when near her perigee, and much horned, I thought I ſaw anfractus or roughneſſes on the concave part of the enlightened edge, (ſuch as we ſee in the new moon), which I have repreſented as nearly as I could in Fig. 12.

2. In my frequent views of Jupiter, I find his belts to have great varieties; that they change their places; that their breadths alter, being ſometimes broader, ſometimes conſiderably narrower; that ſometimes they are more in number, ſometimes fewer; ſometimes they are darker and blacker; ſometimes thin and only like a miſt. Towards the poles of Jupiter are the greateſt alterations, there being ſometimes few or no belts towards one or the other pole; ſometimes one quite acroſs the polar parts, another but reaching half, or a part of the way. And even about the middle, or equatorial parts of Jupiter, where there are always belts, (and commonly two), yet theſe vary conſiderably. Sometimes they are nearer one another; ſometimes farther aſunder: ſometimes they are conſiderably broader, eſpecially that neareſt the middle; ſometimes as conſiderably narrower: ſometimes they both advance towards one pole; and then recede towards the other oppoſite pole. Of many of theſe appearances I took draughts, and

deſigned to have inquired whether they had certain periods; but want of health and leiſure prevented me.

And not only the belts, but the ſpots alſo of Jupiter vary greatly; I do not mean the ſpots occaſioned by the ſhade of the ſatellites, but ſuch as are on the very diſk; which are ſometimes of one form, ſometimes of another; and oftentimes none to be ſeen at all, though the ſame face of Jupiter ſhould be towards us.

3. The laſt thing I ſhall mention is the nebuloſe, which are thoſe glaring whitiſh appearances, ſeen with our teleſcopes in Andromeda's girdle, Hercules's back, Antinous's foot, Orion's ſword, in the Centaur, Sagittary, *etc.* which appear through the teleſcope, ſomewhat after the manner, as Cor Cancri doth to the naked eye.

Theſe nebuloſe I have often viewed with glaſſes of very different lengths, particularly that in *pede Antinoi* with Mr Huygens's: but I confeſs that I could never diſcern what they are; neither indeed could I perceive any great differences in their appearances through a very good glaſs of about 15 foot, and others of 30 and 40 foot, yea, Mr Huygens's of 126.

But indeed the grand obſtacle to all my views with Mr Huygens's glaſs, was the vapours near the horizon, which not only obſcured the object, but cauſed ſo great a trembling and dancing thereof, as made it no leſs difficult to be diſtinctly and accurately viewed, than a thing held in the hand is, when danced and ſhaken backwards and forwards. By this means my expectations from Mr Huygens's glaſs were frequently fruſtrated, excepting in nights that were more than ordinarily ſerene and clear; which was commonly in ſuch as were the moſt intenſely froſty and cold.

Finding it therefore unlikely that I ſhould do much more with Mr Huygens's glaſs than I had done, I reſtored it to the Royal Society which lent it me, (and to whom Mr Huygens bequeathed it by his laſt will), contenting myſelf with the views it had given me, and that I had diſcovered it to be an excellent glaſs; which Dr Hook, and ſome others of our beſt judges, took to be good for nothing.

And now having given this account of my obſervations, and alſo ſhewed what hindered my completing of them, (which may excite farther inquiries, as well as ſerve to vindicate myſelf), I ſhall recommend theſe things to ſuch as have good glaſſes, particularly to the diligence and accuracy of my very ingenious friend, the reverend Mr Pound, into whoſe hands the Royal Society have put that noble bequeſt of Mr Huygens, and who is ſo well accommodated for raiſing and uſing that glaſs, as to have ſeen (among other conſiderable things) the five ſatellites in Saturn; which I confeſs I could never reach, nor above three of them that I could be ſure were ſuch, becauſe it is not very eaſy to diſtinguiſh which are ſatellites, and which are ſmall teleſcopic ſtars, which very frequently ſhew themſelves in a glaſs of ſuch goodneſs as that is. I remember that I once verily thought I had found out ſeven ſatellites of Saturn, with this very glaſs of Mr Huygens, ſo regularly were they placed in reſpect of Saturn. But when I came to examine them the following nights, I found that there were really no more than two ſatellites, the reſt being ſmall fixt ſtars. But Mr Pound's ſkill and exactneſs in ſuch obſervations, is, I know, ſo great, (and I may add that of my ſagacious friend Dr Halley too, who I hear hath ſeen the ſame), that I do not ſay this by way of caution to them, although it may ſerve as ſuch to many others.

And now for a cloſe, I ſhall take this opportunity of publicly owning, with all honour and thankfulneſs, the generous offer made me by ſome of my friends, eminent in their ſtations, as well as ſkill and abilities in the laws, who would have made me a preſent of the Maypole in the Strand, (which was to be taken down), or any other pole I thought convenient for the management of Mr Huygens's glaſs. But as my incapacity of accepting the favour of thoſe noble Mæcenaſes, hath been the occaſion of that excellent glaſs being put into better hands; ſo I aſſure myſelf their expectations are abundantly anſwered, by the number and goodneſs of the obſervations that have been, and will be made therewith.

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# A PRELIMINARY DISCOURSE CONCERNING

## The ſyſtems of the heavens, the habitability of the planets, and the plurality of worlds, uſeful for the reading the following book.

MY *Phyſico-Theology* having met with ſo quick a ſale, as to come to a third impreſſion before the year was expired, but eſpecially the ſolicitations of many learned men, both known and unknown, have given me great encouragement to fulfil my promiſe, in ſending abroad this other part, relating to the heavens: which ſhould ſooner have ſeen the light, but that I was minded not to interrupt the reader's patience with many notes, (which I could not well avoid in my *Phyſico-Theology*, and which my rough draught of this was burthened with), and therefore I threw the greateſt part of them into the text: which neceſſitated me to tranſcribe the whole. And when my hand was in, I new-made ſome part of it, and added many new obſervations of my own, which I then had lately made with ſome very good long glaſſes I had in my hands; one of Campani's grinding; and others of Engliſh work, which exceeded it; but eſpecially one of Mr Huygens's of above 120 feet, which few for goodneſs do ſurpaſs.

Of theſe obſervations the reader ſhould have met with many more, (and I believe ſome of my ingenious friends do expect more), but that I lie under two inconveniencies: one the want of an open free Horizon, my habitation being ſurrounded much with trees. The other, and indeed the chief, the want of a long pole of a 100 or more feet, to raiſe my long glaſs to ſuch an height, as to ſee the heavenly bodies above the thick vapours; which much obſcure all objects near the Horizon, eſpecially when viewed with ſuch long and good glaſſes. But ſince that, two very dangerous fits of ſickneſs, and the increaſe of my age, (both which have much impaired my ſight), have rendered me uncapable of ſuch obſervations, eſpecially at ſuch ſeaſons of the night and weather, as are fitteſt for viewing the heavenly bodies.

And therefore if I have not ſufficiently anſwered the expectations of ſome of my learned and ingenious friends, I hope they will excuſe me, and believe it to be more my calamity than fault that I have done no more; eſpecially among ſuch planets as have advantageouſly preſented themſelves, as Saturn particularly hath, whoſe five or more ſatellites it may be expected I have ſeen; but I could never reach but three of them, and they only when there were but few vapours. And as for the ſpots in Mars and Venus, and their motion round their own axes, after I had a good furniture of excellent glaſſes, I had not any good views of thoſe planets before my ſickneſs, by reaſon of the too great diſtance of Mars from the Earth, and the proximity of Venus to the Sun, and the cloudy weather; and the ſmall altitude which Venus had above the Horizon about that time.

But however, what is here wanting in my own, is ſufficiently made up from the obſervations of others. Of which the learned world hath good ſtore, ſince the invention of the teleſcope; which as it hath made ample diſcoveries of the works of God, ſo hath laid open a new, and a far more grand and noble ſcene of thoſe works than the world before dreamed of, and afforded us a far more rational ſyſtem of the heavens and the univerſe, than was before entertained.

And foraſmuch as I have frequent occaſions in my following book, to ſpeak of, and, according to ſome or other of the ſyſtems of the heavens, it is neceſſary I ſhould, by way of preface, give ſome account of them, to enable ſuch perſons to underſtand my book, as are unacquainted with aſtronomical matters.

Among all the various ſyſtems, I need take notice only of three, the Ptolemaic, the Copernican, and the new ſyſtem. Of each of which in their order.

## *Of the Ptolemaic Syſtem.*

In the Ptolemaic ſyſtem the earth and waters are ſuppoſed to be in the centre of the univerſe; next to which is the element of air, and next above that is the element of fire; next that the orb of Mercury, then that of Venus, then that of the Sun; and above the Sun's orb, thoſe of Mars, Jupiter, and Saturn; and above them all, the Firmament, or orb of the fixed ſtars; then the Cryſtalline Orbs; and laſtly, the Coelum Empyreum, or Heaven of Heavens. All theſe maſſy orbs, and vaſt bodies borne by them, are, in this ſyſtem, ſuppoſed to move round the terraqueous globe once in twenty-four hours: and beſides that in ſome other certain periodical times. For the effecting of which motions, they were forced to contrive ſuch circles as they called Eccentrics and Epicycles, croſſing and interfering with one another; which I could not repreſent in ſo narrow a compaſs as Fig. 1. is, which is a ſcheme of this Ptolemaic ſyſtem; which is univerſally maintained by the Peripatetic philoſophers.

## *Of the Copernican Syſtem.*

The next ſyſtem is the Pythagorean or Copernican, being invented, as ſome imagine, by Pythagoras himſelf. But Diogenes Laertius expreſsly ſaith *, that Pythagoras's opinion was, "that the world was round, containing the earth in the midſt of it." And by Pliny's † account of Pythagoras his diſtances, and orders of the planets, this ſeems to have been his opinion. But the ſame Laertius ‡ affirms Philolaus, the Pythagorean, την γην κινεισθαι κατα κυκλον, πρωτον ειπειν οι δε, Ικεταν Συρακουσιον φασιν· "to have been the firſt "that ſaid the earth was moved in a circle: but

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[*] Lib. viii. in Pythag.

[†] Nat. Hiſt. Lib. ii. cap. 21. 22.

[‡] Ibid. in Philolao.

" ſome ſay, Hicetas the Syracuſian." So Plutarch, in his life of Numa, ſpeaking of Numa's building the temple of Veſta, ſaith, he built it round, and " that a continual fire was kept therein, in imitation of the figure of the earth, or rather of the " whole world itſelf, the middle of which the Pythagoreans (not Pythagoras) take to be the ſeat " of fire."

This ſyſtem (whoever was the inventor of it) Copernicus, a canon of Thorn, reſtored about the beginning of the fifteenth century, and was followed therein by many conſiderable men, as Rheticus, Maeſtlinus, Kepler, Rothman, Bullialdus, Lanſberge, Herigonius, Schickard, Gaſſendus, Galilaeo, and others. The laſt of which (by the ill-will and inſtigation of Pope Urban VIII. as it is ſuppoſed) had the misfortune to fall under the cenſure of, and to have his Copernican tenets condemned by, the inquiſition, and was forced to abjure them. The particulars of which, if the reader hath a mind to ſee, he may find them in Riccioli's Almageſt *.

According to this ſyſtem, the Sun is ſuppoſed to be in the centre, and the heavens and earth to revolve round about him according to their ſeveral periods: firſt, Mercury in near 88 days; then Ve-

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* Lib. 8. ſect. 4. cap. 40.

nus, in ſomewhat above 224 days; then the Earth with its ſatellite the Moon, in 365 one fourth days; then Mars in about 687 days; then Jupiter with his four moons in about 4333 days; and laſtly, Saturn in ſomewhat above 10759 days, with his five or more moons revolving about him.

And beyond, or above all theſe, is the firmament, or the region of fixt Stars, which are all ſuppoſed to be at equal diſtances from their centre the Sun.

This is the Copernican ſyſtem, which I have given a ſcheme of in Fig. 2. And ſo far as this ſyſtem relates to the motion of the earth, and the Sun reſting in the centre, I prefer it to the Ptolemaic Hypotheſis, on theſe five following accounts.

1. Becauſe it is far more agreeable to nature, which never goes a round about way, but always acts by the moſt compendious, eaſy and ſimple methods. And in the Copernican way, that is performed by one, or a few eaſy revolutions, which, in the other way, is made the work of the whole heavens, and of many ſtrange and unnatural orbs. Thus the diurnal motion is accounted for by one revolution of the earth, which all the whole heavens are called in for, in the other way; ſo for the periodical motions of the planets, their

ſtations, retrogradations, and direct motions, they are all accounted for by one eaſy, ſingle motion round the Sun, for which, in the Ptolemaic way, they are forced to invent divers ſtrange, unnatural, interfering Eccentrics and Epicycles: An hypotheſis ſo bungling and monſtrous, as gave occaſion to a certain king to ſay, "If he had been "of God's council when he made the heavens, "he could have taught him to have mended his "work."

2. As the Copernican is far more eaſy and agreeable to nature than the Ptolemaic ſyſtem, ſo it is far more complete, and anſwerable to the various phaenomena of the planets; ſeveral of which the Ptolemaic hypotheſis either very aukwardly ſolves, or doth not at all come up to. I might inſtance here in divers particulars relating to Venus and Mercury, as why the earth is never between them and the Sun, which the Ptolemaic ſyſtem gives no tolerable account of, and but poor accounts of other of their phaenomena, as alſo of thoſe of the moon and the other planets. I might ſhew alſo how incoherent and improper the motions aſſigned to the heavenly bodies are in the Ptolemaic way, as that the moon ſhould move round once in a month, the other planets in ſuch and ſuch periods as are aſſigned to them;

the firmament or fixt-ſtars in 25 or 26 thouſand years; the ſphere beyond that in 1700 years; and the tenth ſphere in 3400 years; and the outermoſt of all, the *Primum Mobile*, which moves all the reſt, in only 24 hours. Which are motions ſo unproportional, and diſagreeable, that are ſufficient to ſubvert the whole hypotheſis. But it would be endleſs to enter into a detail of ſuch incoherences and improprieties as the Ptolemaic ſyſtem abounds with.

3. The prodigious and inconceivable rapidity aſſigned by the Ptolemaics to the heavens, is by the Copernican ſcheme taken off, and a far more eaſy and tolerable motion ſubſtituted in its room. For, is it not a far more eaſy motion for the earth to revolve round its own axis in 24 hours, than for ſo great a number of far more maſſy, and far diſtant globes, to revolve round the earth in the ſame ſpace of time? If the maintainers of the Ptolemaic ſyſtem do object againſt the motion of the earth, that it would make us dizzy, and ſhatter our globe to pieces, what a precipitant, how terrible a rapidity muſt that of the heavens be?

What a velocity muſt the Sun have to run its courſe, at the diſtance of 21 or 22 Semidiameters of the earth? What a velocity muſt that of the fixt-ſtars, eſpecially that of the *Primum Mobile* be, at far greater diſtances than the Sun is?

4. It is an inconteſtable argument of the Sun being the centre of the Planets about him, and not the earth, that their motions and diſtances reſpect the Sun, and not the earth. For with regard to the Sun, the primary Planets have a very due motion, in proportion to their ſeveral diſtances; that is, their motions round the Sun, are in ſeſquiplicate proportion to their diſtances from him: but this proportion doth not hold at all with relation to the earth. But as for the ſecondary planets, round Saturn, Jupiter, and the Earth, it is very certain that they have the ſame reſpect to their primaries, as theſe primaries have to the Sun; that is, "the ſquares of their revo-"lutions are as the cubes of their diſtances." And as it is very certain and viſible, that the ſecondary planets reſpect their primaries as their centres, and move round them, ſo it is in ſome meaſure (one would think) no leſs certain, and beyond doubt, that all the primary planets which have the ſelf-ſame reſpect to, and motion with regard to the Sun, as thoſe ſecondaries have to their primaries; that thoſe primaries, I ſay, do move round him as their centre, and not about the earth, to whom they have no ſuch reſpect.

5. The laſt argument I ſhall alledge for my preference of the Copernican to the Ptolemaic ſy-

ſtem, is from the great parity and congruity obſervable among all the works of the creation; which have a manifeſt harmony, and great agreement with one another.

Thus in our preſent caſe, it is manifeſt to our ſight, that every globe we have any good views of, hath ſuch like motions, as thoſe are which we aſcribe to the earth. The Sun indeed being in the centre, is as it were fixt there, and hath no periodical motion: but yet the other motion round its own axis, we can manifeſtly diſcern.

And as for all the planets which move round about the Sun, they have, as far as it is poſſible for us to ſee them, ſuch motions as thoſe we aſcribe to the earth; namely, a diurnal rotation round their own axis, and a periodical revolution round the Sun. And if this be manifeſt in the other planets, what ſhould hinder its being ſo in our own? Why not be ſuppoſed to be moved as well as the reſt, when it is very certain that either it hath thoſe motions, or the heavens have ſo? and it is far more natural and eaſy for the earth to perform them, than for the heavens, as hath been already ſhewn.

Thus having ſhewn how far more probable the Copernican ſyſtem is than the Ptolemaic, ſo far as it relates to the motions of the heavens and earth, and the Sun being in the centre, it remains (beſore I proceed to the third and laſt ſyſtem) that I ſhould anſwer ſome objections alledged againſt this ſyſtem, partly from ſcripture, and partly from philoſophy and ſight.

The objections from ſcripture are ſuch as ſeem to aſſert the immobility and reſt of the earth, and the motion of the Sun and heavenly bodies.

The texts that are brought to prove the immobility and reſt of the earth, are, 1 Chron. xvi. 30. ‘ The world ſhall be ſtable, that it be ‘ not moved.’ The ſame is ſaid, Pſalm xciii. 1. ‘ The world alſo is eſtabliſhed, that it cannot be ‘ moved.’ And ſo the ſame again, Pſalm xcvi. 10. In Pſalm civ. 5. God is ſaid to ‘ lay the foundations of the earth, that it ſhould not be ‘ moved for ever.’ And laſtly, Solomon, Eccleſ. i. 4. aſſerts, that ‘ the earth abideth for ever.’ Like to which is that of the Pſalmiſt, Pſalm cxix. 90. ‘ Thou haſt eſtabliſhed the earth, and it ‘ abideth.’ Theſe are the principal texts which ſeem to aſſert the immobility and ſtability of the earth.

The principal texts which mention the motion of the Sun and heavenly bodies, are ſuch as aſcribe, riſing, ſetting, or ſtanding ſtill to them. Thus Gen. xix. 23. ‘ The Sun was riſen upon ‘ the earth, when Lot entered into Zoar.’ And

Gen. xv. 17. 'When the Sun went down, and 'it was dark, a ſmoking furnace,' &c. So Eccl. i. 5. 'The Sun ariſeth, and the Sun goeth down, 'and haſteth to the place where he aroſe.' So Pſal. xix. 5. 6. the Sun is ſaid to 'come out of 'his chamber like a bridegroom, and to rejoice 'as a ſtrong man to run a race. That his going 'forth is from the end of heaven, and his circuit 'unto the ends of it.' Purſuant to which expreſſions of the Sun's moving, it is ſaid alſo to ſtand ſtill, and to go backwards. Thus Joſhua x. 12. 13. 'Sun, ſtand thou ſtill upon Gibeon, and 'thou Moon in the valley of Ajalon. And the 'Sun ſtood ſtill, and the Moon ſtayed.——So the 'Sun ſtood ſtill in the midſt of heaven, and haſted not to go down about a whole day.' And in 2 Kings xx. 10. and Iſaiah xxxviii. 8. the Sun is ſaid to have returned ten degrees backward, in one of the places, and its ſhadow to have done ſo in the other.

Theſe are the chief texts of ſcripture, which ſeem to lie againſt the Copernican hypotheſis. In anſwer to which, this may be ſaid in general to them all; that ſince the deſign of the holy writings is not to inſtruct men in philoſophical, but divine matters, therefore it is not neceſſary to reſtrain the ſenſe of thoſe texts to the ſtrict propriety of the words, but take them to be ſpoken according to the appearance of things, and the vulgar notions and opinions which men have of them, not according to their reality, or philoſophical verity. Thus in divers other inſtances the holy ſcriptures ſpeak; and thus even philoſophers themſelves ſpeak. Yea, the Copernicans themſelves, although they profeſſedly own, and defend the contrary; yet in vulgar ſpeaking in our preſent caſe, ſay, The Sun riſeth, ſetteth, and moveth, *&c.* making that to be the act of the Sun in vulgar diſcourſe, which they contend to be in reality performed by the earth. And if philoſophers, and others ſhould not thus expreſs themſelves according to the appearance of things, and mens vulgar apprehenſions of them, it would need a comment, and they muſt explain themſelves every time they ſpeak, in order to their being underſtood.

Having given this general anſwer, I ſhall next conſider the particular texts themſelves, and ſee whether they neceſſarily infer what they are brought for the proof.

And in the firſt place, as for the texts brought to prove the immobility of the earth, it is manifeſt, that the ſtability of the world, mentioned in the three firſt texts, doth not relate to the earth's motion, either annual or diurnal, but to the condition, ſtate and order of the world inhabiting the earth, particularly the peace and proſperity thereof. One of our own lateſt, and moſt learned Commentators, the late biſhop Patrick *, underſtands the goſpel ſtate to be meant in the firſt and third of the texts. And his paraphraſe on that in Pſalm xciii. 1. is, " He who made the " world, will ſupport that excellent order wherein " we are ſettled; ſo that it ſhall not be in the " power of men to diſturb what he hath eſta" bliſhed."

As for what is ſaid in Pſalm civ. 5. it is manifeſt that the Pſalmiſt is there celebrating the works of creation, and that there was as fair an occaſion of ſpeaking of the earth's reſt, in relation to its two motions, as any where. But yet even here alſo the ſecurity and permanency of its ſtate is the thing aimed at. The laſt moſt learned Commentator thus paraphraſes on the place †, " Who hath ſettled the maſſy globe of the earth, " even in the liquid air, upon ſuch firm founda" tions, that none of thoſe ſtorms and tempeſts, " which beat upon it from without, nor any

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* See his Comment. on Chron. and Paraph. on Pſalms.

† Biſhop Patrick's Paraph. on Pſalm civ. 5.

" commotions from within, can ever ſtir it out of " the place he hath fixed for it."

As for the two remaining places in Eccleſ. and Pſalm cxix. it is plain enough that their deſign is to ſhew the vanity and inſtability of the things of this world, that they are all more fleeting and uncertain than other matters, even than the earth itſelf, on which they have their reſidence. In Eccleſiaſtes, the wiſe man (who had undertaken to prove all things here below to be vanity) begins with the ſtate of man himſelf, and ſhews that to be more fickle and tranſitory than the earth, on which the various generations of men live, and to which their bodies do all return again. The generations of men paſs away; *but the earth abideth for ever*, in the ſame unalterable condition, without ſuch going and coming as that of the generations of men have.

In Pſalm cxix. 90. the Pſalmiſt celebrates God's faithfulneſs to all the various and ſucceeding generations of the world, which he ſhews to be as conſtant and unalterable as the earth itſelf, which God hath ſo eſtabliſhed, that it abideth through all the ſeveral generations of men, when they at the ſame time are fleeting and changing.

Thus it appears, that all thoſe ſeveral texts which aſſert the ſtability of the world, or earth, prove nothing againſt the earth's motion in a philoſophical ſenſe; only expreſs ſome moral theological truths.

And ſo the ſame may be ſaid of thoſe other places of ſcripture, which mention the motion of the Sun and other heavenly bodies, that ſay they riſe, ſet, and perform the motions which the Copernicans aſcribe to the earth. If we ſhould take theſe expreſſions in a philoſophical, ſtrict, literal ſenſe, and not as vulgar expreſſions, ariſing from the appearance of things; we ſhall find that very odd and unreaſonable concluſions may as well be collected from thoſe ſcriptures, as the Sun's motion; as that the Sun hath animal life, motion, and deſire, being ſaid to act theſe things itſelf, to riſe, to ſet, yea, to haſte to the place of his riſing, or as the Hebrew hath it, to pant after, or eagerly to deſire it*. So in Pſalm xix. the elegant Pſalmiſt giving a poetical deſcription of this noble and admirable work of God, the Sun, ſaith, ' God hath, in the heavens, made a tabernacle for him; as if the Sun had an houſe, a reſting place provided for him; from which he comes daily forth with beauty and luſtre, as reſplendent as that of a bridegroom, and with the ſame ardency, joy, and diligence runs his courſe, as a champion doth his

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[*] SHAF anhelavit, inhiavit. Vid. Buxtorf. Lexicon.

race. And laſtly, his going forth is ſaid to be from the end of the heaven, and his circuit to reach to the ends thereof;' as though the heavens had two extremities, or was (as the ancients fancied the earth to be) a long large plane bounded by the ocean, under which they imagined the Sun betook himſelf, and was thence ſaid *tingere ſe oceano*, to dip himſelf in the ocean when he ſet.

And as in theſe places of ſcripture the Sun is ſaid to move; ſo in the other place he is ſaid to ſtand ſtill, and to go backward. But we ſhall find that very abſurd concluſions would follow the taking of thoſe texts in a ſtrict literal ſenſe. For in Joſhua the Sun is ordered to ſtand ſtill upon Gibeon, and the Moon in the valley of Ajalon. But it would be very abſurd to take this in a literal ſenſe, and imagine thoſe two great luminaries were confined in thoſe two places, otherwiſe than in appearance to the victorious Iſraelites. And if ſo conſiderable a part of the tranſaction be ſpoken according to its appearance, why not the whole? Why might not this ſtation as well be an arreſt of the earth's motion, as of that of the heavens, if the whole miracle was not (as ſome not improbably think) effected by means of ſome preternatural refractions, or extraordinary meteors? etc.

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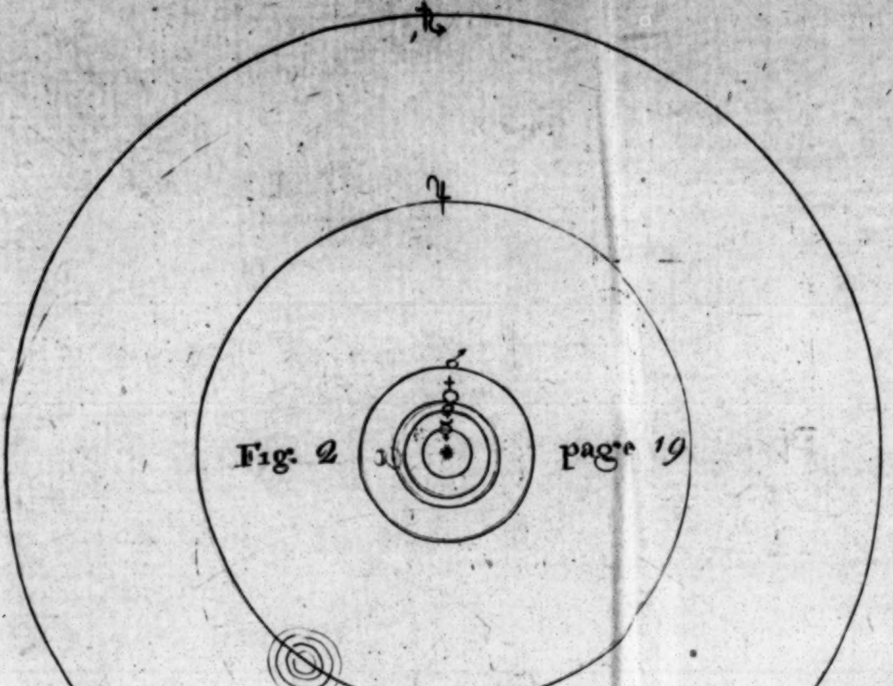

Fig. 2 page 19

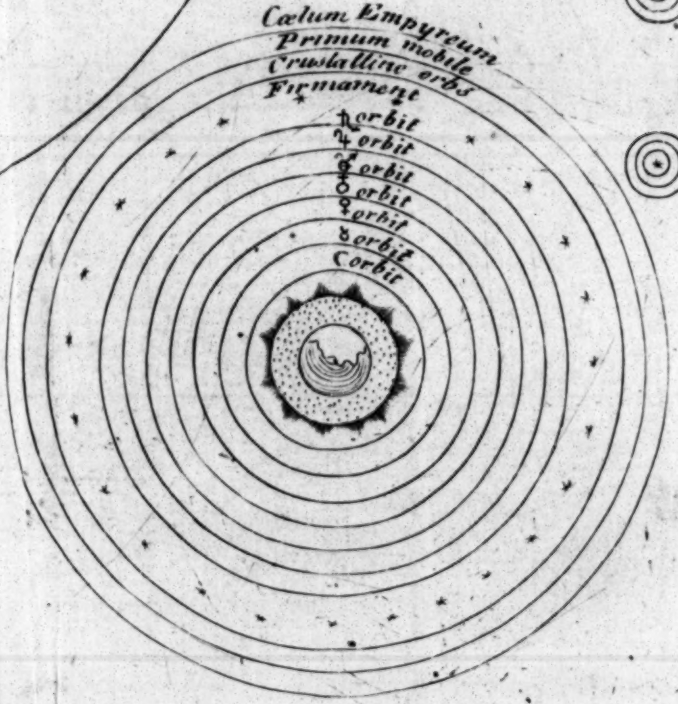

Fig. 1 $p^{e}$ 17

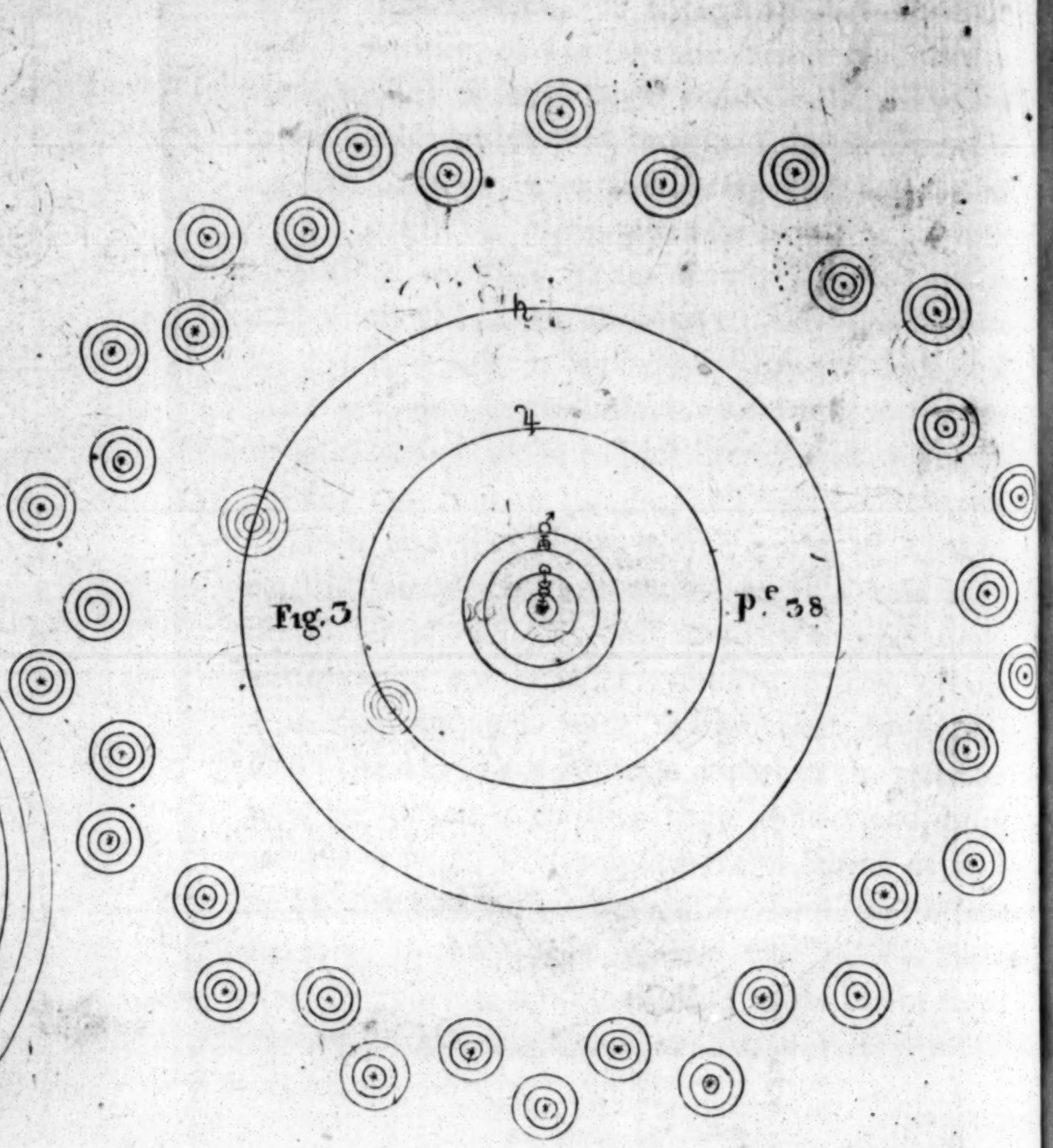

Fig. 3 $p^{e}$ 38

And ſo for the receſs of the Sun, or its ſhadow in Hezekiah's caſe, that which in appearance ſeemed to be the action of the Sun, is by divers learned men thought to have been the effect of ſuch like extraordinary refractions or meteors, as I mentioned in the laſt caſe: or if it was a real receſs, why not of the earth, rather than the Sun and whole heavens?

Thus having anſwered the particular texts, it doth not appear that the ſcriptures oppoſe the Copernican ſyſtem, but that thoſe paſſages which ſeem to do ſo, are ſpoken more according as things appear, than as really they are. For as St Hierom ſaith *, "*Conſuetudinis ſcripturarum eſt.* "———It is the cuſtom of the ſcriptures, for "the hiſtorian ſo to relate the opinion men had "of many matters, as at that time thoſe matters "were by all people taken to be." And in another place †, "There are many things in the "holy ſcriptures, which are ſpoken according "to the opinion of the time in which they were "done, and not according to their reality." And this is no other than what is very reaſonable, and ſuitable to the end and deſign of the holy ſcriptures, which, as I have ſaid, is rather to inſtruct men in divine and moral doctrines, than philoſophical truths. And agreeably hereto St Auguſtine anſwers this very doubt concerning the motion of the heavens †. "Some of the brethren (ſaith "he) move a queſtion, whether the heavens "ſtand ſtill or are moved, becauſe, ſay they, if "they are moved, how is it a firmament? and "if they ſtand ſtill, how do the ſtars, which are "believed to be fixed in them, revolve from eaſt "to weſt, the northern ſtars deſcribing leſſer cir"cles near the pole?———To which, ſaith "he, I anſwer, that theſe things do greatly re"quire ſeveral ſubtle and laborious reaſons, to "diſcover truly whether the matter be ſo, or not "ſo. For the entering upon, and diſcuſſing of "which, I have neither time, nor is it fit it ſhould "be done to ſuch as we deſire to inſtruct in the "way of ſalvation, for the neceſſary benefit of the "holy church."

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* Hieron in Joſh. x. † In Jerem. xxviii.

Having thus anſwered the objections from ſcripture, I ſhall, in the laſt place, conſider thoſe brought from ſenſe and philoſophy.

The objection from ſenſe is, that we ſee the heavenly bodies actually to move, and therefore ought to believe they do ſo. But there is no weight at all in this, becauſe whether we ourſelves, or the object moveth, it amounts to the ſame.

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† Auguſt. de Geneſi ad Literam. lib. ii. cap. 10.

As is manifeſt to any one carried in a boat or chariot; the progreſſive motion of which produceth the appearance of a regreſſive motion in the unmoved objects we look upon; according to Virgil's deſcription of Aeneas and his company's leaving their port:

*Provehimur portu, terræque urbeſque recedunt* *.

*i. e.* "Both land and towns receded when we left "our port." As for the reaſon hereof, I ſhall refer to the opinions, particularly the famous Kepler, who, in his Optices Aſtronom. hath deſignedly handled this point.

The objections from philoſophy are too numerous to be diſtinctly anſwered, eſpecially ſuch as ſeem very frivolous, particularly thoſe grounded on a ſuppoſition of the verity of the Ariſtotelian philoſophy, as the immutability and incorruptibility of the heavens, *&c.* For anſwers to which, I ſhall refer the reader to Galilaeo's Syſtem. Mundi. But for ſuch objections as ſeem to have ſome reaſon in them, they are chiefly theſe, That if the earth be moved from W. to E. a bullet ſhot weſt-ward would have a farther range, than one ſhot eaſt-ward; or if ſhot N. or S. it would miſs the mark; or if perpendicularly upright, it would drop to the weſt-ward of the gun. That a weight dropped from the top of a tower would not fall down juſt at the bottom of the tower, as we ſee it doth. That birds flying towards the E. would be hindered in their flight, but forwarded in flying the contrary way; with much more to the ſame purpoſe. But not to enter into a detail of anſwers that might be given to the preceding objections from the laws of motion, and the rules of mechanics and mathematics; I ſhall only make uſe of the moſt ingenious Galilaeo's plain experiment, which anſwers all or moſt of the objections *. ‘Shut, ſaith he, yourſelf up with your friend in the great cabin of a ſhip, together with a parcel of gnats and flies, and other little winged creatures. Procure alſo a great tub of water, and fiſhes therein. Hang alſo a bottle of water up, to empty itſelf drop by drop into another ſuch bottle placed underneath with a narrow neck. Whilſt the ſhip lies ſtill, diligently obſerve how thoſe little winged creatures fly with the like ſwiftneſs towards every part of the cabin; how the fiſhes ſwim indifferently towards all ſides; and how the deſcending drops all fall into the bottle underneath. And if you throw any thing to your friend, you need uſe no more force one

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* Aeneid. lib. iii. v. 72.

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† Syſtem. Mundi, dial. ii.

‘ way than another, provided the diſtance be equal. And if you leap, you will reach as far one way as the other. Having obſerved theſe particulars whilſt the ſhip lies ſtill, make the ſhip to ſail with what velocity you pleaſe, and ſo long as the motion is uniform, not fluctuating this way and that way, you ſhall not perceive there is any alteration in the aforeſaid effects; neither can you from them conclude whether the ſhip moveth or ſtandeth ſtill. But in leaping you ſhall reach as far on the floor as you did before; nor by reaſon of the ſhip's motion, ſhall you make a longer leap towards the poop than the prow, notwithſtanding that whilſt you were up in the air, the floor under your feet had run the contrary way to your leap. And if you caſt any thing to your companion, you need uſe no more ſtrength to make it reach him, if he ſhould be towards the prow, and you towards the poop, than if you ſtood in a contrary poſition. The drops ſhall fall into the lower bottle, and not one towards the poop, although the ſhip ſhall have run many feet, whilſt the drop was in the air. The fiſhes in the water ſhall have no more trouble in ſwimming towards the forepart of the tub, than towards the hinder part, but ſhall make towards 'the bait with equal ſwiftneſs, on any ſide of the 'tub. And laſtly, the gnats and flies ſhall con'tinue their flight indifferently towards all parts, 'and never be driven together towards the ſide of 'the cabin next the prow, as if wearied with 'following the ſwift motion of the ſhip. And if 'by burning a few grains of incenſe, you make 'a little ſmoak, you ſhall perceive it to aſcend on 'high, and hang like a cloud, moving indiffer'ently this way and that, without any inclination 'to one ſide more than another. The cauſe of 'which correſpondence of the effects, is, that 'the ſhip's motion is common to all things con'tained in it, and to the air alſo: I mean, when 'thoſe things are ſhut up in the cabin: but when 'they are above deck in the open air, and not 'obliged to follow the ſhip's courſe, differences 'more or leſs may ariſe among the fore-named ef'fects.'

Thus Galilaeo by this one obſervation hath anſwered the moſt conſiderable objections deduced from philoſophy againſt the motion of the earth. And thus much ſhall ſuffice for the explication and proof of the Copernican ſyſtem; eſpecially that part of it relating to the Solar ſyſtem. Which things I have more largely than ordinary inſiſted on, for the ſatisfaction of many that I am ſenſible doubt of them, and particularly ſome of my friends, (and thoſe not unlearned too), who may be apt to read my following book with prejudice, whereſoever I favour the Copernican notions.

## *Of the New Syſtem.*

And now I paſs from the ſecond ſyſtem to the third, which is called the new ſyſtem, and by ſome the true ſyſtem; which extends the univerſe to a far more immenſe compaſs, than any of the other ſyſtems do, even to an indefinite ſpace; and repleniſhes it with a far more grand retinue than ever was before aſcribed unto it.

The new ſyſtem is the ſame with the Copernican, as to the ſyſtem of the Sun and its planets; as may be ſeen by the ſcheme of it in Fig. 3. But then, whereas the Copernican hypotheſis ſuppoſeth the firmament of the fixt-ſtars to be the bounds of the univerſe, and to be placed at equal diſtance from its centre the Sun; the new ſyſtem ſuppoſeth there are many other ſyſtems of ſuns and planets, beſides that in which we have our reſidence: namely, that every fixt-ſtar is a ſun, and encompaſſed with a ſyſtem of planets, both primary and ſecondary, as well as ours.

Theſe ſeveral ſyſtems of the fixt-ſtars, as they are at a great and ſufficient diſtance from the Sun and us, ſo they are imagined to be at as due and regular diſtances from one another. By which means it is, that thoſe multitudes of fixt-ſtars appear to us of different magnitudes; the neareſt to us, large; thoſe farther and farther, leſs and leſs.

Of thoſe ſyſtems of the fixt-ſtars I have given a rude repreſentation in Fig. 3. together with that of the Sun; which may ſerve to give an unſkilful reader ſome conception of the ſtate of the univerſe; although there be but little likeneſs in it, for want of room to lay out all the ſeveral ſyſtems in due proportion; which is neceſſary to a true repreſentation of the matter.

In this 3d Fig the fixt-ſtars with their ſyſtems, repreſented by little circles about thoſe ſtars, which circles ſignify the orbits of their reſpective planets, are placed without the limits of the ſolar ſyſtem; and the ſolar ſyſtem is ſet in the centre of the univerſe, and figured as a more grand and magnificent part thereof. And ſo it may be looked upon by us, by reaſon of its proximity and relation to us. But whether it be really ſo, whether it be in the centre of the univerſe, and whether, among all the noble train of fixt ſtars, there be no ſyſtem exceeding ours in its magnificent retinue of planets, both primary and ſecondary, and other admirable contrivances, is a difficulty, as out of the reach of our glaſſes, ſo conſequently above our ability to fathom, although not at all improbable. But be the various ſyſtems of the univerſe as they will as to their dignity, it is ſufficient that in all probability there are many of them, even as many as there are fixt-ſtars, which are without number.

This ſyſtem of the univerſe, as it is phyſically demonſtrable, ſo is what, for the moſt part, I have followed in the enſuing book, but not ſo rigorouſly and obſtinately, as utterly to exclude or oppugn any other ſyſtem; becauſe as the works of GOD are truly great, and ſufficiently manifeſt their excellent and magnificence in any ſyſtem; ſo I was willing to ſhew the ſame in ſuch ſyſtems as I had occaſion to ſpeak of them in; becauſe I would not offend, and conſequently not bar the force of my arguments upon ſuch readers, as might happen to be wedded to the Ariſtotelian principles, or prejudiced to the Ptolemaic, or any other ſyſtem: not that I had myſelf any doubts about this new ſyſtem, but think it to be far the moſt rational and probable of any, for theſe reaſons.

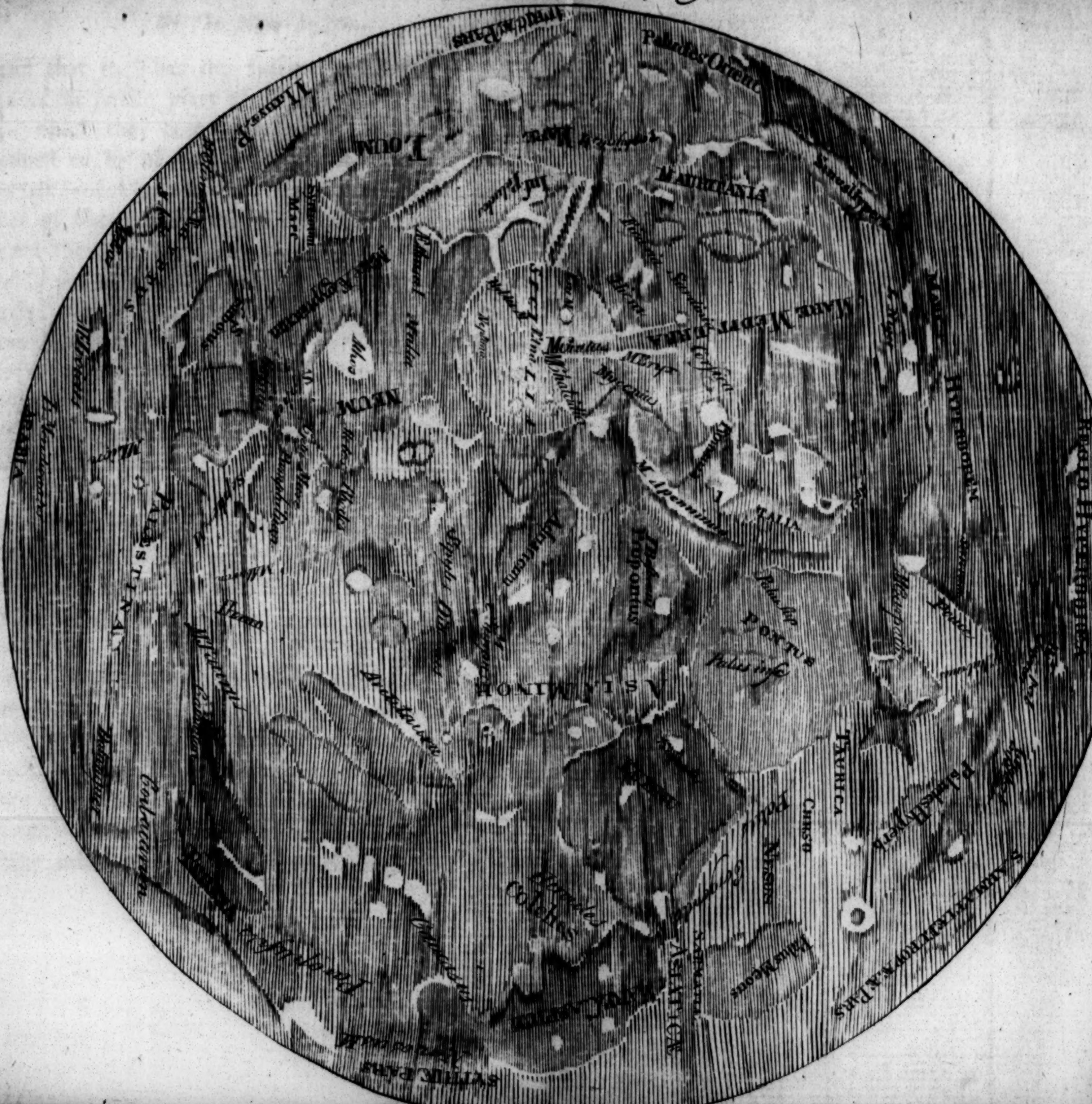
1. Becauſe it is far the moſt magnificent of any; and worthy of an infinite CREATOR; whoſe power

and wiſdom, as they are without bounds or meaſure, ſo may in all probability exert themſelves in the creation of many ſyſtems as well as one. And as myriads of ſyſtems are more for the glory of God, and more demonſtrate his attributes than one; ſo it is no leſs probable than poſſible, there may be many beſides this which we have the privilege of living in. But it is very highly probable the matter is ſo, by reaſon,

2. We ſee it is really ſo, as far as it is poſſible it can be diſcerned by us, at ſuch immenſe diſtances as thoſe ſyſtems of the fixt-ſtars are from us. Our glaſſes are indeed too weak ſo to reach thoſe ſyſtems, as to give us any aſſurance of our ſeeing the planets themſelves, that encompaſs any of the fixt-ſtars. We cannot ſay we ſee them actually moving round their reſpective ſuns or ſtars. But this we can diſcern, *viz.* That the fixt ſtars have the nature of ſuns, as I have made probable in Book 2. Chap. 2. As alſo, that there are ſome things very like unto planets, which ſometimes appear and diſappear in the regions of the fixt ſtars; as I have ſhewn in my diſcourſe of new ſtars, Book 2. Chap. 3.

But beſides what I have ſaid there, I have this farther to add from ſome late obſervations I have made ſince my writing that part of my book;

Fig 10 page 28



and that is, That the Galaxy being well known to be the fertile place of the new ſtars, the region in which they commonly appear, I am much inclined to be of opinion, that the whiteneſs there is not cauſed by the bare light of the great number of fixt-ſtars in that place, as hath commonly been thought, but partly by their light, and partly (if not chiefly) by the reflections of their planets; which ſtop and reflect, intermix and blend the light of their reſpective ſtars or ſuns, and ſo cauſe the whiteneſs the Galaxy preſents us with; which hath rather the colour of the reflected light of our Moon, than the primary light of our Sun.

And that there are planets enough for this purpoſe, I ſuſpect, becauſe I have ſome reaſon to imagine that there are many more new-ſtars in the milky way, (all which I take to be a kind of planetary globes), than have ever yet been taken notice of, and that many of thoſe prodigious numbers of teleſcopial-ſtars viſible there, are of the numbers of new ſtars or planets, and not of fixt ſtars only. This ſuſpicion I have for ſome time had, but eſpecially lately from my views of the new ſtar that now begins to diſappear in the Swan's neck. Which gave me occaſion to inſpect ſome other parts of that conſtellation, moſt parts of which are well repleniſhed with a numerous train of ſmall ſtars. Amongſt which, ſometimes methoughts more have preſented themſelves through one and the ſame glaſs, and ſometimes I have miſſed ſome I thought I before ſaw: and ſometimes alſo methoughts I have ſeen them nearer to, and ſometimes farther off thoſe ſtars that did conſtantly preſent themſelves. But as theſe things are to myſelf novel, and what I confeſs I have rather ſuſpicions of than certainty, I ſhall refer them to the future obſervations of myſelf, and others, for their confirmation; eſpecially becauſe thoſe approximations and receſſes of ſome of the little ſtars I ſpeak of, ſuit not with the obſervations of ſome very eminent Aſtronomers.

Theſe obſervations, as they will open to us a new and admirable ſcene of the heavens, (if it be as I imagine), ſo I earneſtly recommend the inquiry into it to ſuch as delight in thoſe matters. For the doing of which, I conceive it may be ſufficient, and the eaſieſt courſe, to make the obſervations in ſome one part of the milky way, as in ſome part of the Swan for inſtance; and I would adviſe that an area of the heavens may be taken in, containing as much or a little more than falleth within the compaſs of the teleſcope you make uſe of: which was the way I practiſed, in that part of the heavens in which I obſerved. All the ſtars that fall within this area, an exact map muſt be taken of, which will ſhew when any variations happen. And for taking in the larger area of the heavens, a glaſs of 6 or 8 feet is ſufficient, and rather better for the purpoſe than longer glaſſes, which take in leſs, and are more troubleſome in uſing.

Having thus repreſented the ſtate of the univerſe according to the new ſyſtem of it, the uſual queſtion is, What is the uſe of ſo many planets as we ſee about the Sun, and ſo many as are imagined to be about the fixt-ſtars? To which the anſwer is, That they are worlds, or places of habitation, which is concluded from their being habitable, and well provided for habitation. This is pretty manifeſt in our ſolar planets, from their being opake bodies as our earth is, conſiſting in all probability of land and waters, hills and valleys, having atmoſpheres about them, moons miniſtering unto them, and being enlightened, warmed and influenced by the Sun; whoſe yearly viſits they receive, for ſeaſons; and frequent returns or revolutions, for days and nights. All which particulars are fully treated of in the following book, and need not therefore to be anticipated here. Only there is one thing, which for want of ſufficient obſervations, I could not ſo fully ſpeak of as I would; and that is concerning the ſeas in the moon, in book 5. chap. 4. note (*a*), whoſe very exiſtence Mr Huygens * denies, ſaying, *Marium vero ſimilitudinem illic nullam reperio*, &c. i. e. "In the moon I find "no likeneſs of ſeas, although Kepler and moſt "others are of a different opinion. For thoſe vaſt "plane regions, which are much darker than the "mountainous parts, and are commonly taken "for ſeas, and bear the names of oceans; in thoſe "very places viewed with a long teleſcope, I find "little round cavities with ſhadows falling with"in them; which cannot agree with the ſurface "of the ſea: as alſo thoſe very large fields, when "carefully viewed, do not preſent us with a ſu"perficies altogether equal. Wherefore theſe "cannot be ſeas, but are ſuch places as conſiſt "of a leſs bright matter than that which is in "the more hilly parts, but in which alſo there "are ſome places brighter than others." Thus the moſt ingenious Mr Huygens, who then proceeds to ſhew, that there are neither rivers, clouds, air, or vapours.

But that there are ſeas or great collections of water, and conſequently rivers, clouds, air and vapours in the moon, I ſhall make out from ſome of my own views and obſervations; many of which were made with Mr Huygens's own long glaſs before mentioned: through which, and all other long glaſſes, inſtead of imagining the lunar ſpots to be unlike ſeas, I have always thought them to look more like ſeas, than through ſhort glaſſes.

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* Coſmotheoros, p. 114.

It is true indeed, that in thoſe ſpots we take to be ſeas, there are ſuch cavities as Mr Huygens ſpeaks of, or rather mountains with ſhaded cavities in them, as alſo ſome parts leſs dark than others. Thus in the ſoutherly parts of the Lunar Euxine and Mediterranean, in the Sinus Sirbonis, the Egyptian, and divers other ſeas, there are ſeveral ſuch parts that appear more luminous than others, ſome having the appearance of rocks and iſlands, ſome of large ſhallows, particularly towards the ſhores, and eſpecially in the ſeas bordering on the continents, ſuch as the great ſouthern continent of the Lunar Egypt and Paleſtine. But this is no concluſive argument of thoſe parts not being ſeas; becauſe they may be ſeas having many iſlands and ſhallows in them. But then in other parts, and even in ſome parts of theſe laſt named, the ſpots appear darker, and with but few of thoſe eminencies or iſlands, thoſe brighter or ſhallow parts. Thus the northerly Euxine and

Mediterranean, the Palus Maeotis, and many other of thoſe lunar ſeas; few of thoſe parts that have the aſpect of iſlands or ſhallows are to be diſcerned in them, only one here, and another there, at conſiderable diſtances from one another.

And in this very manner I doubt not our terraqueous globe would appear, if viewed at the moon, or at ſome miles aloft. We ſhould there perceive our deep oceans would be of a darker colour, like the darkeſt ſpots of the moon; and the ſingle iſles of St Helena and Aſceſſion, and the more numerous ones of Ladrones, Canaries, Azores, *&c.* to have the ſame appearance that the few ſcattered iſlands have in the deeper lunar ſeas: and our ſhallow ſeas, with their numerous rocks and iſlands diſperſed about them, eſpecially towards the continents, would look as thoſe in the moon do.

That a reader, unacquainted with the geography of the moon, may apprehend what I have ſaid here and elſewhere, concerning the parts and appearances of the moon, I have repreſented them in Fig. 10. and 11. In Fig. 10. the face of the full moon is repreſented, its bright and dark parts, with moſt of the names given them by Hevelius, whoſe lunar geography is juſtly the moſt followed.

In Fig. 11. I have repreſented the appearance of the moon's edge on this laſt Nov. 4. 1714. ſoon after the quadrature, for the explication of what is ſaid concerning the evenneſs of the ſurface of the lunar ſpots in book 5. chap. 4 note *a.* It may be there obſerved, that the ſurfaces of all the ſeas appear ſtrait and level, only the top of here and there a rock or iſland preſents itſelf at a ſmall diſtance. Thus the ſurface of the Hyperborean ſea between *a* and *b* appears even and level, although through a teleſcope, that ſea looks but like a great lake or marſh. So do the parts of the Mediterranean about *d*, from *b* to *i*, except when they are interrupted by rocks or land, as they are at *b*, *g*, *b*, and *c*. At the laſt of which places, begins a ridge of hills encompaſſing the northern part of the Mediterranean, which makes a pretty ſhew in the teleſcope.

And now conſidering how accompliſhed the Moon, and all the other planets are for habitation, how ſolemn an apparatus is in them for this ſervice; and conſidering alſo, that theſe accoutrements relate to their reſpective planets only, and in all probability are of little or no uſe to our earth; with great reaſon therefore the maintainers of the new ſyſtem conclude thoſe planets, yea, all the planets of the Sun, and of the fixt-ſtars alſo, to be habitable worlds; places, as accommodated for habitations, ſo ſtocked with proper inhabitants.

But now the next queſtion commonly put is, What creatures are they inhabited with? But this is a difficulty not to be reſolved without a revelation, or far better inſtruments than the world hath hitherto been acquainted with. But if the reader ſhould have a mind to amuſe himſelf with probable gueſſes about the furniture of the planets of our ſolar ſyſtem, what countries it is probable are there, what vegetables are produced, what minerals and metals are afforded, what animals live there, what parts, faculties and endowments they have, with much more to the ſame purpoſe; he may find a pleaſant entertainment enough in the great Mr Chriſtian Huygens's Coſmotheoros, and ſome other authors that have written on the ſubject. To which I ſhall refer him, rather than give either him or myſelf any farther trouble about theſe matters, which are merely conjectural.

Thus having, for the unſkilful reader, given an account of the three ſyſtems principally concerned in the following book; and having alſo, for the ſake of the doubting reader, inſiſted more largely than ordinary upon the two laſt of thoſe ſyſtems, little remaineth for the putting an end to this long preface, but to make my excuſe (if it needs any) for aſſigning the diameters and diſtances of the heavenly bodies in Engliſh miles, rather than other larger meaſures, which would perhaps have come nearer the truth. But this was alſo for the ſake of ſuch as are not very converſant in aſtronomical matters and dimenſions, who can better underſtand you, when you ſay, it is ſo many miles, than ſo many degrees, minutes, or ſeconds, or ſemi-diameters of the earth, or the other planets.

And now for a concluſion, I ſhall only intreat all my readers to join with me in their earneſt prayers, that as this work is deſigned for the good of mankind, particularly for the conviction of infidels and irreligious, for the promotion of the fear and honour of GOD, and the cultivating of true religion, ſo it may have its deſired effect.

W. DERHAM.

n long preface, but to make my excuse (if t[illegible] any) for omitting the [illegible] and situa- of the heavenly bodies in English miles, rather in other larger measures, which would perhaps ve come nearer the truth. But this was for the sake of such as are not very conversant in onomical matters and calculations, who can er understand you, when you talk to ny miles, than so many degrees, minutes, or onds, or semi-diameters of the earth, or the n planets.

And now to conclude, I shall only intreat my readers [illegible] ders, that [illegible] [illegible] eminence, particularly [illegible] constitution of [illegible] ly and attention, for the promotion of the y and honour of God, and the cultivation of religion, [illegible]

[illegible]

# A
# SURVEY
# OF THE
# HEAVENS.

## INTRODUCTION.

THE Pſalmiſt ſaith[*], "The heavens declare the glory of God; and the firmament ſheweth," publicly declareth, telleth forth, or preacheth his *handy-work*, as the Hebrew word ſignifies[†]; that "day unto day uttereth ſpeech, and night unto night ſheweth," or telleth forth, *knowledge*. Which language of the heavens is ſo plain, and their characters ſo legible, that all, even the moſt barbarous nations, that have no ſkill either in languages or letters, are able to underſtand and read what they proclaim. "There is no ſpeech nor language where their voice is not heard: their line is gone out through all the earth, and their words to the end of the world."

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[*] Pſalm xix. 1. 2. 3.

[†] NAGAD ſignificat aliquid verbis efferre, coram nunciare, annunciare. Cornad. Kircher, Concord. col. 226. vol. 2. It is derived from *Neged, coram, ante.*

That this obſervation of the Pſalmiſt is agreeable to experience, is manifeſt from the deductions which all nations have made from God's works, particularly from thoſe of the heavens; namely, that there is a GOD; and that ſuch as have pretended to atheiſm, and have deduced God's works from chance, *etc.* are ſingular and monſtrous in their opinions. Thus ſaith Ælian *, "There "never was any barbarian that contemned the "Deity, nor called in queſtion whether there be "any Gods or no. No man, neither Indian, nor "Celt, nor Ægyptian, ever entertained any ſuch "thought as Eumerus the Meſſenian, or Dionyſius the Phrygian, or Hippo, or Diagoras, or "Socias, or Epicurus." So one of Plato's arguments for the proof of a God, is † the unanimous "conſent of all, both Greeks and Barbarians, "who confeſs there are Gods." And Plutarch ‡, agreeable to what our Pſalmiſt affirms, tells us whence they collected this knowledge of a Deity. “ Men, ſaith he, began to acknowledge a God, “ when they ſaw the ſtars maintain ſo great a ‘ harmony, and the days and nights through all ‘ the year, both in ſummer and winter, to ob- “ ſerve their ſtated riſings and ſettings.” And to paſs over a great deal of this kind, that I could cite from divers heathen authors, “ What, ſaith “ the Stoick in Tully *, can be ſo plain and clear, “ as when we behold the heavens, and view the “ heavenly bodies, that we ſhould conclude there “ is ſome Deity of a moſt excellent mind, by “ which theſe things are governed !——a preſent “ and Almighty God. Which he that doubts of, “ I do not underſtand, ſaith he, why he ſhould “ not as well doubt whether there be a Sun or “ no that ſhines.” And then he goes on to prove that this can be no idle fancy depending on the caprice of man, but a well-grounded ſubſtantial opinion, bearing the teſt of ages, and confirmed by the length of time. “ For, ſaith he, time wears “ out the figments of opinions, but confirms the “ judgements of nature ;” or ſuch notions as are grounded upon the true judgement and nature of things. “ For which reaſon, ſaith he, both among

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* De variis Hiſt. lib. ii. cap. 31.

† De Legibus, lib. x.

‡ De placet. Philoſ. lib. i. c. 6.

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* Quid enim poteſt eſſe tam apertum, tamque perſpicuum, cum coelum ſuſpeximus, *etc.* De Nat. Deor. lib. ii. c. 2.

" ourſelves, and in other nations, the veneration " of the Gods, and the ſacredneſs of religion, " augment and improve every day more and " more."

Thus, ' the heavens declare the glory of God,' even to the heathen world, ſo manifeſtly are they the handy-work of God. And that they are his work, will appear by taking a view of theſe ſeven particulars.

I. The magnitude of the heavens.
II. The great number of the heavenly bodies.
III. Their diſtances.
IV. Their motions.
V. Their figures.
VI. Their gravity.
VII. Their light and heat, and the admirable proviſions made for thoſe benefits.

# BOOK I.

## Of the MAGNITUDE of the UNIVERSE, and the Bodies therein contained.

### CHAP. I.

*The ancient and modern reckonings compared.*

BEFORE the invention of the teleſcope, the univerſe was thought to be confined within far more narrow bounds than it is ſince found to be, the fixt-ſtars being imagined to be all placed in the ſtarry heavens, (which they called the *firmament*), at equal diſtances from the earth (the centre), like ſo many golden nails driven in the top of ſome arched roof, or other circular concave, encompaſſing our eye. Theſe, although far more narrow bounds, and a more ſcanty reckoning than it ſhould be, yet were ſufficient to ſhew who was the maker of ſuch a ſtupendous arch, and ſo noble a train as is contained therein.

But according to the modern reckoning, (which is far the moſt rational, and grounded upon better phaenomena), we ſhall find this branch of the creation far more magnificent, and worthy of its infinite CREATOR, than thoſe former computations made it.

And how grand and magnificent a ſtructure the heavens are, will appear by a diſtinct conſideration of the magnitude of the heavenly bodies themſelves; and of the ſpace in which they are.

## CHAP. II.

### *The* MAGNITUDE *of the heavenly Bodies.*

ALthough we are not able to give a certain determination of the magnitude of the heavenly bodies, by reaſon of their vaſt diſtances, yet enough we know, and are ſure of concerning their immenſe magnitudes, to convince any one that they are the works of God. But to come to particulars.

The meaſure by which we uſually gage and compare the heavenly bodies, is our terraqueous globe; of whoſe dimenſions and bulk we can make a pretty good eſtimate, having tolerably good and accurate obſervations leading us thereto: the particulars of which I have had occaſion elſewhere to ſpecify *a*.

By theſe obſervations, it appears that the diameter of this our globe is above 79 thouſand miles; that conſequently its ſurface is a good deal above 199 millions of miles, and its ſolid content or bulk near 265 thouſand millions of miles. If therefore we ſhould go no farther from home than our own globe, a maſs we here have worthy of an infinite Creator, a work proclaiming that great Being that made it.

But as vaſt a body as this ſeems to be, it is much leſs than many, yea, moſt of the heavenly bodies that are viſible to us, except two or three of the planets, which ſeem to be leſs than our globe, namely, Mars, whoſe diameter is reckoned to be but 4875 Engliſh miles, and the Moon, whoſe diameter is but 2175 miles; and Mercury,

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[a] Phyſico-Theology, book ii. ch. 2. In which place I have made uſe of Mr Picart's meaſure of the earth. But notwithſtanding the difference be but ſmall, *viz.* a little above 32 miles in the whole diameter of our globe, yet I ſhall make uſe here of our Mr Norwood's and Monſ Caſſini's meaſures, becauſe they agree to almoſt a nicety, and Mr Caſſini's were made (by the French king's command) at greater diſtances, with the greateſt accuracy. And according to theſe meaſures, the diameter of the earth is 79677 Engliſh miles, its ſurface 199444201 miles, and its ſolid content 264856000000 miles.

whoſe diameter is 2748 miles *b*; but yet theſe are vaſt amazing bodies too. But for the reſt; there is good reaſon to imagine their bulk exceeds that of our terraqueous globe. Thus the two ſuperior planets by far exceed us; Saturn being computed at 93451 miles in diameter, and conſequently at 427318300000000 miles in its bulk; and Jupiter at 120653 miles in diameter, and 920011200000000 in bulk. But yet as amazing maſſes as theſe all are, yet they are all far outdone by that ſtupendous globe of fire, the Sun; which as it is the fountain of light and heat to all the planets about it, affording them by his benign rays and kindly influence, the great pleaſures and comforts of life; ſo doth it as far ſurpaſs them in its bulk; its apparent dia-

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*b* The number of miles which I have here, and all along aſſigned to the diameters of the ſeveral planets, are the mean number between Mr Flamſteed's in Mr Whiſton's aſtronomical lectures, and Mr Huygens's in his Syſt. Saturn. Coſmotheor. which (as Mr Whiſton firſt ſuggeſted to me) ſeem to be neareſt the truth. For whereas the rays of light, when intercepted by the edge of a knife or other body, are (as Sir Iſaac Newton obſerves, in his Princip. L. 1. Prop. 96.) ſomewhat bent, as if attracted from a ſtrait line by that body; and whereas Mr Flamſteed's meaſures were taken wi a micrometer that pinches or claſps the oppoſite edges of planet, which would incurvate the rays one way; and Mr Huygens's were taken with the interpoſition of a thin tapering plate covering the planet as far as the extremity of its face which would cauſe an incurvation of the rays the contrary way; therefore Mr Flamſteed's meaſures are as much too little, as Mr Huygens's are too large, and conſequently th mean between them probably neareſt the truth.

meter being computed at 822148 Engliſh miles, and its ſolid content at 290971000000000000 miles, ſuppoſing the face we ſee of the Sun to be its true and real globe.

Thus ſtupendous are the magnitudes of the globes of this our ſolar ſyſtem. But theſe are not all, nor perhaps the moſt conſiderable bodies, of the univerſe. For the fixt-ſtars, although in appearance but ſo many golden or flaming ſpots, yet are with great probability, ſuppoſed to be ſo many Suns, ſurrounded with their reſpective ſyſtems of planets, as our Sun is; and imagined to be no leſs in magnitude, if not greater, (ſome of them at leaſt), than our Sun is, but only diminiſhed in appearance by their prodigious diſtances from us.

If now we reflect upon the prodigious maſſes of thoſe many heavenly bodies that preſent themſelves to our view, and many more I ſhall ſhew are unſeen; what a ſurpriſing ſcene do the heavens afford us of the great CREATOR's power! A train of ſuch immenſe bodies, that what leſs than an almighty hand could firſt find matter ſufficient for, and then compoſe, ſuch magnificent works. But yet what is the magnitude of all theſe bodies to that immenſe ſpace in which they are? Which is the next thing to be conſidered.

## CHAP. III.

### *Of the* IMMENSITY *of the Heavens.*

IT is neceſſary that I ſhould give a diſtinct conſideration to the immenſe ſpace poſſeſſed by the heavenly bodies, becauſe it was once imagined to be limited by the narrower bounds of the *Ptolemaic Syſtem*, by that which they called the απλανης, the *Starry Concameration*, or *Firmament* of the fixt-ſtars, as I have before intimated; but now with far greater probability, and reaſon, it is extended to an indefinitely larger ſpace, a ſpace ſufficient, without all doubt, to contain all the noble variety of ſyſtems therein; not only our own of the Sun, but all thoſe others I mentioned of the fixt-ſtars alſo. But for the better proof, and more eaſy apprehenſion of the magnitude of this vaſt expanded ſpace, let it be conſidered,

1. That ſome, if not every one, of thoſe vaſt globes of the univerſe hath a motion. This is, in ſome, manifeſt to our ſight; and may eaſily be concluded of all, from the conſtant ſimilitude and conſent that the works of nature have with one another. But in what manner theſe motions are performed, whether by the motion of the hea-

venly bodies round the earth, or by the earth round its axis, or any other way, it matters not much now to inquire.

2. It is manifeſt, that the earth is ſet at ſuch a due diſtance from the heavenly bodies, and the heavenly bodies at ſuch a due diſtance from one another, as not to interfere, claſh with, or diſorder one another. Nay, ſo great is their diſtance, ſo convenient their ſituation, that they do not ſo much as eclipſe one another, except ſuch planets as are called ſecondary.

3. It is farther manifeſt alſo, that thoſe vaſt bodies are ſo far off, as to appear extremely ſmall to our eye, conſidering their prodigious magnitudes. Now for the effecting of this, or any of the other matters, it is neceſſary that there be a ſufficient ſpace. And, that there is ſuch, and what that ſpace is, we may make a judgement of, by conſidering particulars, according to the beſt obſervations we have of theſe things.

And to begin neareſt home; the neareſt of the heavenly bodies to us, is the Moon; whoſe orb is the leaſt of any of the celeſtial globes, but yet ſhe takes up a ſpace of near 480 thouſand Engliſh miles in breadth * to perform her revolution in.

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* The Moon's mean diſtance from the earth, according to Sir Iſaac Newton's Princip. p. 434 is 60 Semidiameters one

And as for the earth, if, with the moderns, we ſuppoſe it, together with its ſatellite the Moon, to revolve round the Sun; or (which amounts to the ſame thing) if the Sun revolves round the earth, this Magnus Orbis, as it is uſually called, is a ſpace of above 540 millions of miles in circumference *b*, or 172 millions of miles breadth. And if to that we add the increment cauſed by the ſweep of the Moon, or the excurſion of her orb

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fourth of the earth, according to which the diameter of the Moon's orbit is 479905 Engliſh miles.

*b* Concerning the diſtance between the Sun and the earth, there is a great diſagreement between the former and latter Aſtronomers, occaſioned by the diſagreement between their obſervations of the Sun's horizontal parallax, (which is equal to the earth's ſemidiameter viewed at the Sun), Tycho making it three minutes, Kepler but one, Bullialdus 2 minutes, 21 ſeconds, and Riccioli but 28 ſeconds. Conſequently the diſtances ariſing from hence are leſs than thoſe of the later Aſtronomers. The very ingenious and accurate Monſ. de La Hire in his Tab. Aſtr. thinks the Sun's horizontal parallax to be not above 6 ſeconds, and his diſtance therefore to be 34377 ſemidiameters of the earth, or 136952807 Engliſh miles. But although his obſervations were made ſince, yet I ſhall make uſe of Monſ. Caſſini's number, being deduced from very ingenious and accurate obſervations of the parallax of Mars, and agreeing nearly with the determination of two great men, Mr Flamſteed and Mr Huygens, and I may add Dr Halley too, who make it about 10 or 12000 diameters of the earth. That great Aſtronomer (Monſ. Caſſini I mean) aſſigns a number between them, in his Les Elemens de l' Aſtron. § 37. That the Sun's parallax being ſuppoſed to be 9 one half ſeconds, gives the diſtance of the Sun from the earth 21600 ſemidiameters of the earth; which are equal to 86051398 Engliſh miles. And imagining the *Magnus Orbis* to be a circle, (as it is indeed an ellipſis not much differing beyond the *Magnus Orbis*, we ſhall have a ſpace yet broader by near 280 thouſand miles. But as vaſt a ſpace as this ſeems to be, yet it is not ſuch as to cauſe either the earth or moon to claſh with any of the other celeſtial globes, as I have ſaid; nay, ſo far from that, that not ſo much as their ſhade approaches any of them. In which caſe, what ample orbs muſt the three ſuperior planets have? what a ſpace is neceſſary for them, and their more numerous Moons, to perform their much larger courſes in? And accordingly, ſuch ſpaces they and the reſt of the planets are all found to have: Saturn an orb of 1641526386 Engliſh miles diameter; Jupiter an orb of 895134000 miles; Mars of 262282910 miles; Venus of 124487114 miles; and Mercury an orb of 60621000 Engliſh miles[c]: all of them ſpaces ſo accurately laid out, and diſtances ſo duly proportioned to their revolutions about the Sun, that

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from a circle), the double of that number is the length of its diameter, *viz.* 172102795 Engliſh miles.

Theſe numbers are different from thoſe I have aſſigned in my Phyſico-Theol. Book I chap. 4. Note 5. from a miſtake at that time.

[c] Theſe numbers are deduced from the diſtance between the Sun and earth aſſigned in the preceding note, and Sir Iſaac Newton's diſtances of the Planets from the Sun computed from their periods in his Principia, lib. 3. Phaenom. 4. and are, as I humbly conceive, much more accurate than other calculations that I have met with.

abundantly manifeſt infinite wiſdom to have been concerned in their appointment, as I intend to ſhew in a proper place.

But now after this account of this ſo prodigious a ſpace as that of our ſolar ſyſtem is, what is it to the nearly infinite expanſum occupied by the reſt of the heavenly bodies! Of which we may have a faint adumbration, by conſidering the diſtances which, with the greateſt probability of obſervation and reaſon, are aſſigned to the fixt-ſtars. In order to the making an eſtimate of which matter, let it be ſuppoſed (which is uſually allowed) that the fixt-ſtars are ſo many ſuns; that they are of the ſame, or nearly the ſame magnitude as our Sun is; and that the difference of their magnitudes ariſeth from the difference of their diſtances. If ſo, then it will follow, that the fixt-ſtars are each of them as much farther from us than the Sun, as their apparent diameters are leſs than that of the Sun *. And foraſmuch as few of them appear otherwiſe than as points, even through our beſt teleſcopes, therefore how prodigiouſly farther muſt they needs be from us than the Sun is, as cauſe their appearance to be ſo very much leſs than the Sun? For an example, let us take

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* Compare the ſagacious Dr David Gregory's demonſtration of this, in his Aſtron. lib. 3. Prop. 56. 60. and 61.

one of the fixt-ſtars ſuppoſed to be neareſt to us, as being the brighteſt and largeſt, namely, Syrius. Now this, by accurate obſervations * hath been found to be in appearance 27664 times leſs than the Sun; and conſequently, by the foregoing rule, it is ſo many times farther off than the Sun is, which will amount to above 2 millions of millions of Engliſh miles. And if ſo, what an immenſurable ſpace is the firmament? wherein a great number of ſtars leſſer and leſſer, and conſequently (according to the foregoing ſuppoſition) farther off, are ſeen with our naked eye, and many more diſcovered with our glaſſes, and ſtill many more and more with better glaſſes †, and in all probability many others that eſcape the reach of our utmoſt

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* See Mr Huygens in Coſmotheor. p. 137.

† In viewing the planets with my longer glaſſes, [eſpecially the planets of a weaker light], it often falls out, that divers of the fixt ſtars, and ſome of them very ſmall, preſent themſelves at the ſame time within the glaſs, notwithſtanding its area is not ſufficient to contain both Jupiter and his moſt diſtant ſatellites. By which means it is ſometimes difficult to diſtinguiſh between thoſe fixt ſtars and the ſatellites of the planets. Thus I have ſometimes been ready to fancy, that I ſaw one or more ſatellites near Mars, until, by future obſervations, I perceived they were only ſome of the teleſcopic fixed ſtars lying in the way of Mars. So about Saturn, I have often diſcerned the likeneſs of many ſatellites, but I am not ſure I ever ſaw above three. From whence it is manifeſt, that in all parts of the heavens there are many ſtars which preſent themſelves to our eye through our long glaſſes, that are otherwiſe inviſible to us.

art to deſcry: which may conſequently be as far diſtant from thoſe we ſee, as thoſe are from us.

## CHAP. IV.

### *Practical Deductions from, and Reflections upon the* MAGNITUDE *of the Heavens.*

HAVING ſet forth the prodigious magnitude of the heavenly ſpace, and of the bodies therein contained, before we proceed farther, let us pauſe a little, to conſider what influence theſe things ought to have upon us.

And in ſhort, who can behold the regions above, and conſider the things therein contained, and at the ſame time not own them to *declare the glory of God?* Who can view that immenſurable firmament, in which thoſe bodies are, and not acknowledge his handy work? We admire (as juſtly we may) the vaſt bulk of this our own globe: but when we conſider how much it is ſurpaſſed by moſt of the heavenly bodies, what a point it degenerates into, and how very little more even It, and what we call its great Orb together alſo, are, when ſeen from the heavens, this gives us a juſt and noble idea of the infinite Creator's works, ſuch as is worthy of God, and ſuch as may make us ſlight, not overvalue this little heap on which we dwell, and cauſe our thoughts and deſires to ſoar among the heavenly glories. But for an application of theſe conſiderations, let us hear Seneca's reflections upon the matter [*], who on this account "recommends virtue, not purely becauſe it is a noble thing in "its own nature, and a great bleſſing to be free "from evil, but alſo becauſe it enlargeth the "mind, and prepares it for the knowledge of "heavenly things, and makes it fit to aſſociate "with God [†].——Then, ſaith he, the mind "hath the conſummate and full good of our human ſtate, when having conquered all evil, it "ſoars aloft, and wandering among the ſtars "above, it is able to deride the ſtately ſtructures "of the wealthy, and all their riches.——Neither, ſaith he, can it contemn the porches and "roofs ſhining with ivory, the clipt groves, and "the pleaſant ſtreams conveyed to their houſes, "until it hath wandered throughout the world, "and from above looking down upon this little "globe, covered in a great meaſure by the ſea,

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[*] Nat. Quaeſt. lib. 1. Praefat.

[†] Qui in conſortium Dei veniat.

" and, where not ſo, ſlovenly, and either burnt " up in one part, or frozen in the other, it then " ſaith to itſelf, Is this that little point that is " divided among ſo many nations by fire and " ſword? Oh how ridiculous are the bounds of " mortals, when this river divides this nation, " that mountain boundeth another, and that de- " ſart another? For as for this world, ſaith he, It " is a point in which ye ſail, in which ye war, " in which ye diſpoſe of kingdoms. But above, " are vaſt ſpaces, into the poſſeſſion whereof the " mind is admitted, on condition it hath brought " but little of the body along with it, that it " hath cleanſed itſelf from every filthy thing, and " being diſengaged from the world hath made " itſelf illuſtrious, by being expeditious and light, " and content with little things. When ſuch a " mind, ſaith he, hath touched thoſe celeſtial re- " gions, it is then nouriſhed and grows; and as " if delivered from its bounds, it returns to its " original ſtate. And this argument it hath of its " divinity, that it delights in divine matters, and " is converſant with them, not as things ſtrange, " but its own. There it ſecurely beholds the " riſing and ſetting ſtars, their different courſes, " *etc.* There this curious ſpectator diſcuſſes eve- " ry thing, and ſearches out every thing. And

" indeed what ſhould it do but pry into theſe mat-
" ters, ſince he knows they belong to himſelf?
" Then he contemns the narrow bounds of his
" habitation in this world——And here at laſt he
" learns what he hath long inquired after: There
" he begins to know God [*]."

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[*] Illic incipit DEUM noſſe.

# BOOK II.

## The great NUMBER of the Heavenly Bodies.

### CHAP. I.

### *A general View of the* NUMBERS *of the Heavenly Bodies.*

HAVING, in the preceding book, given a demonſtration of God from the magnitude of the heavenly bodies, I ſhall do the ſame in this from their number; a number ſo great, that we cannot view and conſider them without aſtoniſhment. Were there no more of them than the Sun, and the planets (both primary and ſecondary) ſuppoſed to move about him, there would be a number ſufficient to manifeſt an almighty and wiſe Creator. But when we view the heavens, and ſee ourſelves ſurrounded with ſo prodigious a number of illuſtrious bodies, of various magnitudes; when we go to the other parts of this our globe, from the northern, ſuppoſe, to the ſouthern pole, and there diſcover a great multitude of other ſtars that were never ſeen in our hemiſphere: when we perceive the heavens thick beſet with them in every place; and when (as I already hinted) we view the heavens with our glaſſes, and diſcover many more than our naked eye could reach; and when we again view them with better and better inſtruments, and ſtill diſcover more and more of thoſe ſtarry globes; when particularly we ſurvey what they call the Milky-way, and ſee the prodigious number, I may almoſt ſay cluſters of ſtars, that fill that region of the heavens, and cauſe that remarkable whiteneſs there: I ſay, when we ſee ſuch prodigious numbers of thoſe heavenly bodies, which no art of man can number; and when we farther conſider, that in all probability we do not ſee the half, nay, perchance not the thouſandth part of what the heavens do contain; as we cannot but be ſtruck with amazement at ſuch a multitude of God's glorious works, ſo we cannot but own the great Creator in them; and we are worſe than men, if we do not give him his due praiſes.

## CHAP. II.

### *That the fixt Stars are* SUNS *encompaſſed with Syſtems of Planets.*

ALTHOUGH the number of the erratic and fixt heavenly bodies we ſee are ſufficient to ſet forth the exiſtence and praiſes of their great Creator, yet there is one thing more that I cannot eaſily paſs over, (though it hath only probabilities for it), becauſe it gives us a far more noble and agreeable idea of the creation, than the world was ever, that we know of, acquainted with before; and that is, that the beſt and moſt learned modern Aſtronomers do generally ſuppoſe the great multitude of fixt-ſtars we ſee, or imagine to be in the univerſe, to be ſo many ſuns, and each of them encompaſſed with a ſyſtem of planets like our Sun.

And that the fixt-ſtars are ſuns, or of much the ſame nature as our Sun, there is great reaſon to conclude,

1. Becauſe they are bodies no leſs immenſe (as I have ſaid) than the Sun, but only diminiſhed in appearance, by their prodigious diſtances from us.

2. Becauſe they ſhine by their own native light, not by any borrowed from the Sun. For ſo great are their diſtances from the Sun, and from us alſo, that it is not poſſible their light ſhould be received from the Sun, and reflected to us, as that of the Moon and other planets is. And withal, ſo briſk and vivid is their light, and ſo very ſmall their apparent diameters, when diveſted of their glaring rays, and made to have their true appearance through our teleſcopes, that no queſtion is to be made, but that they ſhine by their own innate light, as our Sun doth.

And if the fixt-ſtars are ſo many Suns, certainly they miniſter to ſome grand uſes in the univerſe, far above what hath uſually been attributed unto them. And what more probable uſes, than to perform the office of ſo many Suns? that is, to enlighten and warm as many ſyſtems of planets; after the manner as our Sun doth the erratics encompaſſing it. And that this is the uſe and office of the fixt-ſtars is probable,

1. Becauſe this is a far more probable and ſuitable uſe for ſo many Suns, ſo many glorious bodies, than to ſay they were made only to enlighten and influence our leſſer, and I may ſay inferior, globe; which another Moon or two, or one or two of thoſe very Suns ſet nearer to us, would

have better done, than all the whole train of heavenly bodies now doth. But inſtead of this, many of them, nay, perhaps, the greateſt number of them, are at ſuch immenſe diſtances, (as ſhall be ſhewn under the next head), that they are out of the reach of our naked eye. In which caſe, what uſe is it likely ſuch great numbers of ſuch immenſe, unſeen, far diſtant bodies can be to our world, when there are ſo many already of divers magnitudes of thoſe that fall under view, that (beſides other much greater uſes they may ſerve in the univerſe) do miniſter to our help and comfort here upon earth, and ſupplying the abſence of the Sun and Moon by night?

2. From the parity, and conſtant uniformity obſervable in all God's works, we have great reaſon to conclude, that every fixt-ſtar hath a ſyſtem of planets, as well as the Sun. For it is certain, that the Sun is a fixt-ſtar to the fixt-ſtars, as they are to the Sun. And in this caſe, if (as the juſtly renowned Mr Chriſtian Huygens * argues) "we "ſhould imagine ourſelves to be placed ſome- "where in the heavenly regions, as far from the "Sun as from the fixt-ſtars, we ſhould then per- "ceive no difference between the one or the o- "ther. For it would be very unlikely that we "ſhould ſee any of the ſolar planets, either by

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* Coſmotheoros, p. 133.

" reaſon of the diminiſhing of their light, or be-
" cauſe their orbs would ſink into the ſame lu-
" cid point with that of the Sun. Being then ſo
" placed, we ſhould imagine all theſe ſtars (both
" Sun and fixt-ſtars) to be much of the ſame na-
" ture and kind; and from a view of any one of
" them nearer to us than the reſt, we ſhould make
" our judgement of them all. And now being,
" ſaith he, by the favour of God, admitted ſo near
" one of them, namely, the Sun, as to ſee ſix
" leſſer globes revolving round about him; and
" other ſecondary ones revolving round ſome of
" them: why ought we not to have the ſame
" judgement of the reſt of thoſe Suns, as of this,
" and think it altogether probable, that this is not
" the only ſtar of all the number that is encom-
" paſſed with ſuch a train, or in any reſpect ex-
" cels the reſt? Neither alſo that this ſtar alone
" revolves round its own axis, but rather that all
" the reſt have ſomewhat of the ſame kind alſo."
And ſo that learned perſon goes on in the further purſuit of his ingenious argument.

3. Beſides thoſe ſtrong probabilities, we have this farther to recommend thoſe imaginations to us, that this account of the univerſe is far more magnificent, worthy of, and becoming the infinite Creator, than any other of the narrower ſchemes.

For here we have the works of the creation, not confined to the more ſcanty limits of the orb, or arch of the fixt-ſtars, or even the larger ſpace of the *Primum Mobile*, which the ancients fancied were the utmoſt bounds of the univerſe, but they are extended to a far larger, as well as more probable, even an indefinite, ſpace; as was ſet forth in the firſt Book. Alſo in this proſpect of the creation, as the earth is diſcarded from being the centre of the univerſe, ſo neither do we make the uſes and offices of all the glorious bodies of the univerſe to centre therein; nay in man alone, according to the old vulgar opinion, that all things were made for man *. But in this our ſcheme we have a far more extenſive, grand, and noble view of God's works: a far greater number of them; not thoſe alone that former ages ſaw, but multitudes of others that the teleſcope hath diſcovered ſince; and all theſe far more orderly placed throughout the heavens, and at more due and agreeable diſtances, and made to ſerve to much more noble and proper ends: for here we have not one ſyſtem of Sun, and planets alone, and one only habitable globe, but myriads of ſyſtems, and more of habitable worlds †, and ſome even in our own ſolar ſyſtem, as well as thoſe of the fixt-ſtars. And conſequently, if in the Sun and its planets, although viewed only here upon the earth at a great diſtance, we find enough to entertain our eye, to captivate our underſtanding, to excite our admiration and praiſes of the infinite Creator and Contriver of them; what an augmentation of theſe glories ſhall we find in great multitudes of them! in all thoſe ſyſtems of the fixt ſtars throughout the univerſe, that I have ſpoken of, and ſhall have occaſion to mention again in the next chapter.

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* See Phyſico-Theol. book ii. chap. 6. note 3.

† See the preface, p. 20.

## CHAP. III.

### *Of* NEW *Stars.*

BESIDES the planets of our ſolar ſyſtem, and the wonderful number of fixt-ſtars, there are ſome others, which are called *New Stars*, which ſometimes appear and diſappear in divers parts of the heavens, and will deſerve a place here.

Some of theſe new ſtars have been taken notice of as early as Hipparchus's time, who ſeeing 'ſuch 'a new ſtar, and doubting whether it often hap'pened, and whether the ſtars we take to be fixt 'were ſo or no; he, therefore, (as Pliny tells 'us *) ſet upon numbering the ſtars for poſterity; 'a difficult taſk, he ſaith, even for a god: and 'by proper inſtruments he marſhalled them in 'ſuch order, that their places and magnitudes 'might be known: by which means it might be 'eaſily found, not only whether they decayed and 'periſhed, or were again renewed; but alſo whe'ther any of them changed their places, or had 'any motion, as alſo whether they increaſed or 'decreaſed." Thus Pliny.

Since which time many other ſuch new ſtars have been taken notice of by others. To paſs by the new ſtars in Hadrian's, Valentinian's, Honorius's, and Otto's times, I ſhall name only ſuch as have been more lately taken notice of by men of good judgement in theſe matters; ſuch were thoſe new ſtars obſerved by Tycho Brahe, David Fabricius, Janſon, Bayer, Kepler, Marius, Byrgius, Holwarda, Hevelius, Montanari, Bullialdus, Caſſini, our Mr Flamſteed, and ſome others †; to which may be added a new ſtar that appears at this very time I am writing, in the neck of the

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* Plin. Nat. Hiſt. lib. ii. c. 26.

† For a catalogue of theſe and other new ſtars, the conſtellations in which they appeared, and other matters relating to them, I ſhall refer to Riccioli's Almageſt. lib. viii. § 2. cap. 1. Hevelii Prodrom. in his deſcription of the comet in 1665. p. 433. the appendix to Mercator's Aſtron. and Mr Lowthorp's Abrig. vol. 1. p. 247.

Swan; the ſame in all probability that hath been ſeen before by Mr Kirch,[*] in 1687, and 1688, and perhaps by Bayer before, as alſo Hevelius and others.

Of theſe new ſtars, there is reaſon to imagine there may be many, by reaſon they are not confined to one part of the heavens, but appear and diſappear in divers conſtellations, and divers parts of thoſe conſtellations, as in Caſſiopeia, the Swan, the Great Bear, Andromeda, Eridanus, the Whale, the Ship, and divers other parts of the heavens.

What theſe new ſtars are, is hard to determine. Meteors they cannot be, becauſe they are of a long continuance, and much too far off for bodies that emit ſo little light as meteors do, to be ſeen by us. And as for other opinions about them they are too many, and too frivolous (ſome of them) to be named[†], except one or two of the moſt probable. Among which, one is of ſome perſons that think they may be ſuch ſtars as have one ſide darker than the other, as one of *Saturn's ſatellites* is ſuppoſed to have, and ſo appear only when the bright ſide is turned towards us, and diſappear as the darker takes place. Some think they may be fixt-ſtars that expire in light and vapours *, and are again rekindled, and recruited by the acceſs of comets. Others take them to be comets themſelves. But if I may be admitted to ſpeak what was formerly my own opinion, I rather took them to be erratics of ſome kind or other; and that for theſe reaſons:

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[*] In the Miſcellanea Berolinenſia, p. 210. Mr Kirch ſaith, he, for ſome time, ſought this ſtar in vain, but at laſt on Auguſt 6. N. S. 1687. he found it with the help of an 8 foot tube, but very ſmall, and that it grew bigger, ſo as on October 23. to be ſeen with the naked eye, until having arrived to its greateſt magnitude, it again became leſs and leſs, and at laſt inviſible even in a teleſcope. By frequent obſervations he diſcovered its motion to be very regular, and its period to be 404 and a half days.

[†] If the reader hath a mind to ſee a variety of theſe opinions, he may find them largely enough handled in Riccioli's Almageſt. ubi ſupra, c. 17.

1. From ſome of them, as I thought, ſeeming to change their places, and appearing ſometimes farther off, and ſometimes nearer unto other ſtars: as I have ſaid in the preface †.

2. From that increaſe and decreaſe of their light and magnitudes that is conſtantly obſerved in them; they being at firſt obſcure, and hardly diſcernible, but by degrees growing bigger and brighter, till ſome of them equal the light of Venus; and others the light of the fixt-ſtars, of the firſt, ſecond, and third magnitudes: and then again as gradually grow leſs and leſs, till they utterly diſappear.

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* This is what Sir Iſaac Newton ſurmiſes in his Princip. lib. iii. prop. 42.

† Page 30.

3. From their periodical motion and return after a certain time. This indeed hath not been ſo carefully and judiciouſly taken notice of as it deſerves, or ſo as to bring their periods under certain determinations; but yet in ſome of Hevelius's and Caſſini's obſervations, it hath been diſcovered that ſome of the ſame ſtars have returned, as particularly that in the Whale's Neck, and that which now appears in the Swan's Neck, which, as I juſt before (pag. 67.) ſaid, hath a period of 404 one half days, according to Mr Kirch's obſervations. Theſe were my reaſons for ſuſpecting thoſe new ſtars to be erratics, rather than fixt ſtars either recruited, or having dark and light ſides.

But the grand difficulty is, what kind of erratics they are, whether wandering ſuns, or planets (like ours) of other ſyſtems? That they ſhould be wandering ſuns, is ſomewhat odd to aſſert: and of what uſe they ſhould be, is hard to imagine, ſince there is nothing of this kind in the univerſe, that we know of, that may aſſiſt our imagination.

And as to the latter opinion, I confeſs I have been much inclined to ſuſpect, that they might be planets revolving round ſuch ſuns, as caſt a much fiercer and more vigorous light than our Sun doth; and that theſe their planets might be more denſe than ours, and have ſurfaces more ſtrongly reflecting light, and perhaps be much larger too. But notwithſtanding that planetary reflected light may be ſent to very great diſtances by theſe means, yet without extravagant ſuppoſitions of this nature, it may be doubted whether it would reach us, ſo far off as the fixt-ſtars are. And beſides this, another doubt is, that although there are divers ſtars near thoſe new ſtars, of greater magnitudes than any of thoſe new ſtars are, which I ever yet have had the fortune to ſee; yet I can ſcarce think them big enough, to conclude them to be the ſuns about which thoſe new ſtars (if planets) move. And therefore being uncertain what to determine in ſo intricate a matter, I ſhall leave it to future better obſervations, (which the late long dark weather hath hindered me in the proſecution of), which I hope may afford us ſo good light, as may lead us into a much greater knowledge of thoſe rare phaenomena.

But whatever thoſe new ſtars are, they are a farther demonſtration of God's power and glory: and that there are many more of the grand works of the creation than what our eyes behold at all, or that we have only now and then a glimpſe of. But if they are planets of other ſyſtems, ſome of thoſe erratics revolving round ſome of the fixt-ſtars, than do they lay open a ſtill more glorious ſcene of God's works, and give us ſuch a repreſentation of the ſtate of the Univerſe, that the world never dreamed of before, that even angels themſelves may be amazed at the ſight of.

# BOOK III.

## The due SITUATION of the Heavenly Bodies.

### CHAP. I.

### *Of the due as well as great* DISTANCE *of the Heavenly Bodies.*

I HAVE before taken notice of the immenſe diſtance of the heavenly bodies, that it is ſuch as makes thoſe vaſt bodies, the fixt-ſtars, (no leſs in all probability, as I ſaid, than the Sun itſelf), to degenerate into ſo many points, yea, to eſcape our eye; nay, more than this, that cauſeth even our own Great Orb which our earth deſcribes about the Sun, to ſink into almoſt a point, or at leaſt a circle of but a few ſeconds diameter. I ſhall therefore ſay no more on that matter. But that which I ſhall ſpeak of in this book, is the due proportion of the diſtances of the heavenly bodies, that they are not ſet at random, like a work of chance, but placed regularly, and in due order, according to the beſt methods of proportion and contrivance. Which will be manifeſt from the following chapters, which will ſhew that the diſtance is ſuch, that none of the globes interfere with one another: but inſtead of that, are in due and the moſt nice, commodious proportion.

## CHAP. II.

### *That none of the Globes of the Univerſe interfere.*

HAD the Univerſe been the work of chance, or any thing but of a wiſe Architect, there would have been a great many blunders and inconveniencies in the ſituation of ſuch a prodigious number of immenſe globes, as the Univerſe doth contain. Some would have been too near, ſome too far off, ſome would have met with, knocked and ſtopped one the other, and ſome would have ſo interfered as to have incommoded the other, ſome way or other. But inſtead of this, every globe throughout the whole creation is, as far as it is poſſible for us to obſerve, ſet at ſuch a due diſtance, as not only to avoid all violent concourſes, but alſo as not to eclipſe or ſhade one the other, where-ever it may be prejudicial, or indeed not uſeful and convenient, or ſo as to hinder one another's kindly influences, or to prejudice one another by noxious ones. This is very manifeſt in our own ſyſtem of the Sun; and becauſe we ſee it not otherwiſe, we may conclude it to be ſo in all; unleſs we ſhould make ſome exception for what is ſuſpected (and indeed only ſuſpected) of Comets, which in their approaches towards the earth, are imagined to cauſe diſeaſes, famines, and other ſuch like judgements of God. But this is only ſurmiſe, and what befals the world at other times, without the viſible approach of any Comet. But however, ſuppoſing that as Comets move in Orbs very different from thoſe of the other heavenly bodies, ſo their effects and influences may be as different; yet this may be, and no doubt is (becauſe it may be proved) with the concurrence, and by the appointment of the divine Providence; who, as Governor of the world, might make ſuch noxious globes to execute his juſtice, by affrighting and chaſtiſing ſinful men, at their approaches to the earth; and not only ſo, but (as ſome have imagined) to be the place of their habitation and torment after death. But ſuppoſing it to be ſo, yet herein is a kind providence manifeſted, that their returns to the earth are but ſeldom *, and their ſtays ſhort, and that they take up many years in paſſing the reſt of their Orbs.

And now whether we conſider the due ſituation of the greateſt part of the heavenly bodies, whereby neither they, nor their influences do interfere; or the more unuſual poſition and motion of Comets; ſtill it appears, that a wiſe and careful Architect was the contriver and orderer of it all: eſpecially if we join what follows in the next chapter.

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* There having of late been great expectations among ſome, of a Comet appearing this year 1718, it may gratify their curioſity to take notice, in this place, of the three Comets, whoſe periods, we imagine, are diſcovered, by the great ſagacity and application of our modern Aſtronomers. The revolution of the firſt of the three, is ſuppoſed to be performed in 75 years; and to have been the ſame Comet that appeared in the year 1682. The ſecond is ſuppoſed to be the Comet that was ſeen in the year 1661, and to revolve round in 129 years. And the third is imagined to be that Comet which appeared in 1680 and 1681, whoſe period is 575 years. And according to Mr Whiſton's determinations, the firſt of theſe three Comets will again appear in the year 1758, the ſecond in 1789, and the third and laſt not till about the year 2255.

## CHAP. III.

### *Of the nice* PROPORTIONS *of the Diſtances of the heavenly Bodies.*

AS it is one great demonſtration of the ingenuity and ſkill of an architect, to give due proportions to his work; ſo we find this to be abundantly manifeſt in all the bodies of the univerſe that fall under our cognizance: among which we may diſcern a curious order, and that due and nice proportions are ſtrictly obſerved in their ſituation.

How the fixt-ſtars are ſituated in reſpect to one another, is impoſſible for us to determine at ſuch prodigious diſtances as they are from us; but they look to us, who can have no regular proſpect of their poſitions, as if placed without any order: like as we ſhould judge of an army of orderly, well diſciplined ſoldiers, at a diſtance, which would appear to us in a confuſed manner, until we came near and had a regular proſpect of them, which we ſhould then find to ſtand well in rank and file. So doubtleſs, if we could have an advantageous proſpect of the fixt-ſtars, we ſhould find them very commodiouſly, and well ſet in the firmament in regard of one another. And this we have great reaſon to conclude from the rules of parity, from that conſtant harmony, and ſimilitude obſervable among all the works of the creation, which fall under our cognizance: particularly this is evident in this region of the Univerſe, to which we belong, and which we have a better proſpect of, and can ſurvey with our inſtruments, I mean, the ſyſtem of the Sun. In this we find every body placed in good order, and at due diſtance, according even to the niceſt rules of proportion.

For the eviction of this matter, let us (according to the moſt received and rational hypotheſis) ſuppoſe the Sun placed in the centre, to influence all his planets with light and heat. Then follow the ſeveral planets, ſurrounding him, not one here, and another there, at all adventures, in a rude manner, like a work of chance, but at due diſtances from the Sun; at proper diſtances from one another; and in ſuch well adjuſted proportion of their velocities and gravities, as makes the ſquares of their revolutions in proportion to the cubes of their diſtances. And this is what is diſcernible in the whole ſolar ſyſtem; not only in the primary planets, that revolve round the Sun, but in the ſecondary planets alſo, that revolve round them. Thus it manifeſtly is in the five Moons that accompany Saturn, and the four accompanying Jupiter. And a moſt ſagacious contrivance this is, manifeſting the preſence and conduct of the Creator, in thus chuſing this proportion I ſpake of, rather than any other. For ſhould the power of gravity (for inſtance) have been ſo conſtituted, as to decreaſe in proportion of the cubes (inſtead of the ſquares) of the diſtances reciprocally; although it might be poſſible to adjuſt a velocity, and I may add, a direction too, ſo as to make bodies deſcribe perfect circles, yet the leaſt exceſs or defect of velocity, or the leaſt obliquity of the direction, would make them deſcribe ſpiral curves, either aſcending *in infinitum*, or elſe deſcending to the centre. And ſuppoſing the orbs (in which thoſe bodies move, and which are ſuppoſed, as I ſaid, to be in proportion of the cubes) perfectly circular, the leaſt adventitious force, even but of an atom, abating or increaſing the velocity, or changing the direction, would bring on the aforeſaid inconveniencies. And if the great Creator and Contriver of the univerſe hath thus wiſely modelled, and cautiouſly methodized this part, this ſyſtem of it where we live, and behold the thing, no great doubt can be made but that he hath done the ſame in the other ſyſtems thereof alſo; that every ſyſtem is ſet at a due diſtance from one the other, and every body in each ſyſtem at its due diſtance alſo from their Sun, or fixt-ſtars.

And now, who can reflect upon theſe things, and not perceive and admire the hand that acteth in them, the contrivance and power of an infinite Workman! For where we have ſuch manifeſt ſtrokes of wiſe order, counſel, and management, of the obſervance of mathematical proportions, can we conclude there was any thing leſs than reaſon, judgement, and mathematical ſkill in the caſe? or that this could be effected by any other power, but that of an intelligent Being, who had wiſdom and power ſufficient for ſuch a work? according to the reaſoning of the Stoic in Cicero, who pleads thus *, "If thou ſhouldſt ſee a large and fair houſe, "thou couldſt not be brought to imagine that "houſe was built by the mice and weeſles, although "thou ſhouldſt not ſee the maſter thereof; ſo, ſaith "he, wouldſt thou not think thyſelf very plainly to "play the fool, if thou ſhouldſt imagine ſo orderly a frame of the world, ſo great a variety "and beauty of the heavenly things, ſo prodigious a quantity and magnitude of ſea and land, to

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* Cic. de Nat. Deor. lib. ii. cap. 6.

" be thy houſe, thy workmanſhip, and not that of " the immortal Gods !" And ſo when we ſee ſuch good order, ſuch due proportions in this region of the Univerſe, and have good reaſon to conclude the ſame may be throughout the whole, can we, without great violence to reaſon, imagine this to be any other than the work of God?

# BOOK IV.

## Of the MOTIONS of the HEAVENS.

### CHAP. I.

### *That the bare* MOTION *of the Heavens and Earth are a Demonſtration of* GOD.

IN treating concerning the motion of the heavenly bodies, it will be neceſſary to take in that of the earth too, it being not eaſy to ſpeak of one without the other. And here there are two things that are manifeſt demonſtrations of the preſence and management of GOD, namely, that ſuch bodies ſhould move at all, and that their motion is ſo regular.

1. That all thoſe vaſt globes of the univerſe ſhould have a motion, muſt of neceſſity be from ſome Being that had power enough to put them in motion. For, as Lactantius well argues *, "There is indeed a power in the ſtars (and the like may be ſaid of the reſt of the globes) of

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* Lactant. Divin. Inſti. lib. ii. cap. 5.

performing their motions, but that is the power of God who made and governs all things, not of the ſtars themſelves that are moved." For it is impoſſible for ſuch lifeleſs, dull, unwieldy bodies, to move themſelves, but what motion they have, they muſt receive from ſomething elſe able to move them.

Now this ſome will ſay may be effected by the vortices ſurrounding the Sun, the earth, or other primary mover *; or from a vectorial power or emanations of the Sun †, or other the like primary movers carrying about and puſhing on ſuch bodies as move about them. But allowing that it is poſſible it might be ſo, yet ſtill we muſt recur to ſome firſt Mover, ſome primary Agent, who was able to ſet that principal mover into motion: and then the caſe amounts to much the ſame, and the argument hath the ſame force, whether we attribute the motion of one, or all the ſeveral globes to the power of God. For in our ſolar ſyſtem, for inſtance, if it ſhould be thought that the ſix primary planets revolving round the Sun, received their motion from his revolution round his own axis; yet let us think, as Plato argues ‡,

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* This was Cartes' notion, and of others long before him.

† This was Kepler's ſcheme.

‡ Plato in Epinom.

" how it is poſſible for ſo prodigious a maſs to be " carried round for ſo long a time, by any natural " cauſe? For which reaſon (ſaith he) I aſſert God " to be the cauſe, and that it is impoſſible it " ſhould be otherwiſe." Thus Plato: whoſe argument is undoubtedly good, ſince, as Ariſtotle argues[†], " Every thing that is moved, muſt of " neceſſity be moved by ſome other thing; and " that thing muſt be moved by ſomething that is " moved either by another, or not by another " thing. If it be moved by that which is moved " by another, we muſt of neceſſity (ſaith he) come " to ſome prime Mover, that is not moved by ano" ther. For, it is impoſſible that what moveth, " and is moved by another, ſhall proceed *in infi" nitum.*"

And now therefore, if in our ſolar ſyſtem, we ſhould imagine the Moon to be wheeled about our earth, by the motion and vectorial power of the earth; and the moons about Saturn and Jupiter, by the motion and vectorial power of thoſe planets; and all the primary planets to be turned round about the Sun by the power of the Sun, yet at laſt we muſt find out a Mover of the Sun itſelf, and thoſe other primaries; a cauſe of ſufficient power to wheel about thoſe prodigious maſſes, of ſuch vaſt bulks, as have before been aſſigned to them, and which, beſides their own weight, are, according to the former hypotheſes, clogged and encumbered with the *vis inertiæ* of all thoſe planets, whether primary or ſecondary, or both, which they drive round. And if this was the caſe, what power can be found ſufficient for this work, but that of the ſame infinite hand that at firſt gave them being!

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[†] Ariſtot. Phyſic. lib. viii. cap. 5.

And ſo for all the reſt of the moving bodies of the Univerſe, ſuch as Comets, the new Stars before ſpoken of [*], and the ſlow motion of the firmament, or fixt-ſtars in 25920 [†] years. This latter I ſhall ſay no more of, becauſe it may not ariſe from any motion of the firmament itſelf, but from ſome other cauſe [‡]. But for Comets, what power but that of the Almighty could give them ſuch prodigious projections, as their trajectories or orbs are found to have? Orbs that run into ſuch amazingly long ellipſes as approach to parabola's, that it is wonderful how their projective force ſhould carry them to ſuch immenſe diſtances, and their gravity at the ſame time bring them back, and incomparably retain them in their orbs.

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[*] Book II. chap. 3.

[†] Ptolemy made this motion to be one degree in 100 years. But others ſince make it to be more. Mr Street, in his Caroline tables, makes it 1 gr. 20 minutes: Hevelius 1 gr. 24 minutes, 46 ſeconds, 50 thirds: but Mr Flamſteed agrees Riccioli's numbers to come neareſt the truth *viz.* 1 gr. 23 minutes, 20 ſeconds, in 100 years, or 50 ſeconds in a year. According to which rate the motion (called the Platonic year) is accompliſhed in 25920 years.

[‡] Sir Iſaac Newton demonſtrates how this may ariſe from the Sphaeroidal figure of the earth. Princip. lib iii. Prop. 21. et lib. i. Prop 66 Coral 20. See the matter alſo more eaſily demonſtrated in Dr Gregory's Aſtron. lib. i. Prop. 64.

And ſo for the new ſtars, which I have ſaid are ſo many ſignals of planetary ſyſtems, diſperſed here and there all over the Univerſe, they are all of them ſo many manifeſtations and demonſtrations of an infinite Being, that hath imparted motion unto them: and they are a ſign alſo, that there are other globes beſides the Sun and its planets, which are moving bodies, even that all the globes in the Univerſe are ſuch, and conſequently ſo many proofs of an Almighty firſt Mover.

Thus the bare motions of the earth, and of the heavens, are ſo many arguments of a divine power therein concerned. But we ſhall moreover find an infinitely wiſe, as well as almighty power herein tranſacting, by what follows in the next chapter.

## CHAP. II.

### *The great* REGULARITY *of the Motions of every Globe.*

HAVING in the preceding chapter ſhewn, that the giving motion to ſuch immenſe, lifeleſs globes, is the work of God, we ſhall find much greater demonſtration thereof, if we conſider that thoſe motions are not at random, in inconvenient lines and orbs, but ſuch, as ſhew wiſe deſign and counſel. I ſhall here ſpecify but two examples, becauſe I ſhall have occaſion to ſay more of this matter hereafter. One is, that all the planets ſhould (when their motions were impreſſed upon them) have their directions or tendencies given, not in lines tending from the centre to the circumference, or very obliquely, but perpendicularly to the radii. The other is, that the motions and orbits of the planets ſhould not interfere with one another, but tend one and the ſame way, from weſt to eaſt, and lie in planes but little inclined to one another, or when inclined, that it ſhould be very beneficially ſo, as I ſhall hereafter ſhew. Theſe, and many other inſtances, and in a word, that every planet ſhould have as many, and various motions, and thoſe as regular, and well contrived and ordered, as the world and its inhabitants have occaſion for, what could all this be but the work of a wiſe and kind, as well as omnipotent Creator, and Orderer of the world's affairs? A work which is as plain a ſignal of God, as that of a clock, or other machine is of man. Thus Tully's Stoic * argues our preſent caſe from the ſhepherd at Actium, when from the top of an hill, he happened at firſt to ſee a ſhip ſailing in the ſea. He was for a while in great amazemen, and ſurpriſe, to ſee ſuch a moving inanimate body, and could not imagine of what a nature it was poſſible it ſhould be, until he perceived, by ſome tokens, that it was made and managed by man. " So, ſaith he, the philoſophers ought to " have done, if haply they had any doubts at the " firſt view of the world: afterwards when they " ſhould behold its determined and equal mo" tions, and all things managed by eſtabliſhed or" ders, and with immutable conſtancy; they " ought then to underſtand, that there is not only " ſome inhabiter in this heavenly, this divine " houſe, but alſo ſome Ruler and Moderator, and

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* De Natura Deorum, lib ii. cap. 35.

" in a manner, Architect of ſo great a work, " ſo noble a performance." This concluſion is ſo natural, ſo cogent, that any thing but ſtupid prejudiced blockheads (as thoſe philoſophers were) would have naturally and eaſily made it. " But " now, ſaith the Stoic *, they ſeem to me not " ſo much as to have any ſuſpicion of the wonder- " fulneſs of the things of the heavens or the earth." And great reaſon the Stoic had for his ſurmiſe. For ſo manifeſt a demonſtration of a Deity, are the motions of the heavens and earth, that if men do not ſee them, it is a ſign of great ſtupidity; and if they will not ſee, and be convinced by them, it is as plain a ſign of their prejudice and perverſeneſs; as will farther appear, by conſidering what an incomparable proviſion is made for the world's good, by the particular motions which are given to the earth and heavens, namely, the Diurnal and Periodical motions.

## CHAP. III.

### *Of the* DIURNAL *Motion of all the ſeveral Globes.*

AS to the Diurnal motion, there is a great probability that our earth, and all the heavenly bodies have a rotation round their ſeveral axes; not all performed indeed in the ſame ſpace, or length of time, but ſome in longer, ſome in ſhorter, times; each time making what we call a day in thoſe ſeveral globes, equivalent, although not equal, to the circumvolution of our earth in twenty-four hours.

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* De Natura Deorum, lib. ii. cap. 36.

This diurnal rotation is viſible in many of the heavenly globes, and highly probable in our own. In the Sun it is very manifeſt from the equable motion of its ſpots, which ſometimes appear in its diſk, and have been obſerved formerly by Galilaeo *, Scheiner †, Tarde ‡, Malapertius, Hevelius ‖,

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* Galilaeo tells us in the third dialogue of his ſyſtem. Mund. that he was the firſt that diſcovered ſpots on the Sun, in the year 1610, which he ſhewed the next year to divers great perſons in Rome. That Scheiner ſent him two letters by Velſerus under the feigned name of Apelles, to deſire his opinion of them; that he concluded them to be alterable, contrary to the received opinion then, of the heavens inalterability; that they were contiguous to the Sun; and that their path over the Sun, ſometimes in a curve, ſometimes in a ſtrait line, argued the annual motion of the earth about the Sun, and not of the Sun about the earth; with more to the ſame purpoſe, which may be ſeen in the ſagacious Author in his firſt and third dialogues.

† Vid. Scheiner's Roſa Urſina.

‡ Vid Tarde's Aſtra Borbonia, who took them to be ſmall Stars interpoſing themſelves between the Sun and us. Of the ſame opinion alſo was Malapertius, who gave them the name of Sydera Auſtriaca.

‖ See Hevelius's opinion of them at large in his Selenography, chap. v. and in the Appendix.

and our countryman, Mr Gaſcoigne, and Mr Crabtree *; and ſince them by Mr Boyle, Dr Hook, and Dr Halley, and Mr Flamſteed and others in England, and by Meſſieurs Caſſini, Picart, and others abroad †; and of late by myſelf and others too. Theſe ſpots have manifeſtly a motion too, as that of a globe moving round upon its poles: for we may perceive them to be perpetually ſhifting their place from the eaſtern to the weſtern limb of the Sun; and in this doing, their daily ſtages and motion exactly correſpond to the motion of a globe; that is, thoſe ſpots ſeemingly ſlower towards the Sun's limb, but nearer the centre of the diſk, larger and ſwifter; and all in exact proportion to a double line of ſines, or a line of ſines on each ſemidiameter of the diſk.

And farther yet, theſe Solar ſpots, as they manifeſtly demonſtrate the Sun to be a moving globe,

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* In their letters, now in my hands, there is an ingenious controverſy between theſe two great men, Mr Gaſcoigne, the inventor of the Micrometer, and Mr Crabtree, concerning the Solar ſpots that appeared about the year 1640; which Mr Gaſcoigne imagined to be great numbers of ſmall planets revolving round the Sun at a ſmall diſtance from him. Mr Crabtree's anſwer and opinion may be ſeen in his letter, which is publiſhed with my own obſervations about the Solar ſpots from 1703 to 1711, in the Philoſ. Tranſ. No. 330.

† The obſervations of thoſe great men which are diſperſed about in the Phil. Tranſ. may be ſeen at one view in Mr Lowthorp's Abridgement, Vol. I. p. 274.

turning round once in ſomewhat above 25 days, ſo they manifeſt themſelves to be ſomething adhering unto, or nigh the Sun's globous body, by means of the different appearance they have in the different parts and poſitions of the Sun: as in the middle of the diſk, if they are round, towards the limb they become more and more oval or long, juſt as ſuch a like ſpot on a common globe would appear, when it is turned ſo as to be viewed by us ſideways, or going out of ſight.

And laſtly, another thing obſervable in and from theſe ſpots is, that they deſcribe various paths or lines over the Sun, ſometimes ſtrait, ſometimes curved towards one pole of the Sun, ſometimes towards the other, exactly correſponding to the different poſitions of the earth, in reſpect of the Sun throughout all parts of the year.

Thus in that maſs, the Sun, we have manifeſtly ſuch a diurnal motion as I ſpake of, or circumvolution round its axis; a motion conſtant and regular, and doubtleſs of as great uſe to ſome office or other, in ſome part or other of the Univerſe, as the motions of the earth are to the inhabitants thereof: and a motion therefore this is, demonſtrating the concurrence of the Almighty.

Neither is it the Sun alone that undergoes a diurnal rotation, but moſt, if not all the erratics about him. Saturn indeed is at ſo great a diſtance from us, that we have not been able to perceive whether or no he hath ſuch a rotation; but as the other planets have it, and there is full as much occaſion for it in Saturn as in them, ſo there is no great doubt to be made, but that he hath ſuch a like diurnal motion, accommodated as well to his ſtate, as it is in the earth and the reſt of the planets.

So Jupiter is diſcovered to have manifeſtly a motion round upon its axis from eaſt to weſt, in the ſpace of 9 h. 56 min. as M. Caſſini * by many repeated obſervations in the year 1665, and other following years, firſt found, from the ſpots obſervable on it: of which there are two kinds, which I myſelf have often ſeen, as well as others before me; a ſhort account of which (although it be a digreſſion) may not be unacceptable to many readers. One kind of theſe jovial ſpots, is only the ſhadow caſt upon the planet by the Satellites intercepting the light of the Sun, when they are interpoſed between the Sun and Jupiter: the other are ſuch as are really in the body of that planet, after the manner of thoſe we ſee in the Moon,

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* See his obſervations in the memoirs de Mathem. et de Phyſique for Jan. 1692.

but not permanent as they are. And by the motion of theſe latter ſpots it is manifeſt, not only that Jupiter revolves round in the time mentioned, but that it is a moving globe alſo, by reaſon (as was ſaid of the Sun) thoſe ſpots move ſwifter, and in larger ſtages towards the middle, than towards the limb of Jupiter's diſk. Alſo ſuch ſpots as are round, about the middle, appear long or oval towards the limb, or edge of the diſk; as was before obſerved of the Sun's ſpots.

As to Mars and Venus, they are both diſcovered to have ſpots, or parts lighter and darker, as well as Jupiter, and to have a motion alſo as he hath. Of thoſe ſpots in Mars, Dr Hook had divers views in the year 1665, which he hath given us figures of [*]: and from thence concluded, that planet had a motion, although he could not determine in what time it was performed. But Mr Huygens expreſsly ſaith [†] it is performed in the ſpace of 24 h. 40 minutes. But for the motion of Venus, Monſ. Caſſini could perceive the ſpots to change their place, and that the planet had a motion, although he could not make out what it was [‡].

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[*] See Philoſ. Tranſ. No. 11. 14.

[†] Coſmotheor. p. 24.

[‡] Mr Caſſini's obſervations diſperſed in the Phil. Tranſ. may be ſeen at one view in Mr Lowthorp's Abrig. Vol. I. p. 382. and 425.

Thus are the primary planets diſcovered to have a diurnal rotation, or ſomewhat very like it at leaſt, all except Saturn, as I ſaid, and Mercury, and our own globe. And as to theſe we have very little, or no reaſon to imagine but that they move as well as the reſt; only we cannot perceive it in Mercury, by reaſon of its proximity to the Sun, and that its elongations are never ſo great, nor ſo long, as to enable us to have any good and ſufficient views of him with our teleſcopes.

And as for our own globe, it is very viſible that either that moves round in 24 hours, or that the Sun and all the heavens move round it in the ſame time. And which of theſe two is the moſt agreeable to the uſual courſe and methods of nature, which performs all its works in the moſt compendious, facile way, let every one judge. And is it not far the moſt compendious, ready, and eaſy way, that the terraqueous globe ſhould wheel about in 24 hours, than that ſo many vaſt bodies of the heavens ſhould be turned about it in that time? Is it not as poſſible, yea as probable, that our leſſer globe ſhould be ſo turned about, as thoſe more maſſy globes of the Sun, Saturn, and Jupiter are about their axes? But I ſhall not enter into a detail of the arguments for the earth's motion, and the objections made againſt it, becauſe I have done it in the preliminary diſcourſe.

Thus having taken a proſpect of the diurnal motions of the great globes of the Univerſe, that fall beſt under the cognizance of our inſtruments, and found that many, and probably all of them have a rotation round in a determinate time; if to this we add the convenience and prodigious uſe of this motion to the ſeveral reſpective globes, we ſhall find that an infinitely wiſe and kind, as well as omnipotent Being was the orderer thereof. For were thoſe globes always to ſtand ſtill, eſpecially the erratics, that owe their light and heat to the Sun, in this caſe, one half of them would be dazzled and parched with everlaſting day, whilſt the other would be involved in everlaſting night and darkneſs. And what the conſequences would be, we may beſt judge from what would befal our own globe, without the kindly alterations of day and night; and that is, that it, at leaſt a great part of it, would ſcarce be habitable; it would neither agree to the ſtate of man, or any other animals; nor to that of vegetables, or indeed any other creature. For one half of the globe would be burning up, at leaſt too much drying, and exhauſted with the beams of the Sun, whilſt the other would be immerged in, and deadened with too long night. And in ſuch a caſe, how could the great works of nature, ſo ſerviceable to the world, be performed? How, for inſtance, could the vapours be raiſed to ſupply the earth with cooling clouds and fertile ſhowers? How could the winds be excited to fan the atmoſphere with their pleaſant and healthful gales? How could the tides be produced, which by their conſtant agitations keep the waters ſweet and clean, and prevent their poiſoning the world?

And as the courſe and functions of nature would be thus affected, ſo would the ſtate of the creatures be no leſs For how could thoſe of the vegetable kingdoms be animated and excited by the kindly heat of the day, and then again tempered and invigorated by the no leſs kindly dews, and influences of the night? How could men and all other animals diſpatch their buſineſs, gather their food, and perform all the various labours and offices of the day, and then recruit and repoſe themſelves with reſt, ſleep, and due perſpiration, and whatever elſe may be owing to the ſalutiferous influences of the night, and abſence of the Sun?

Theſe, and ten thouſand as great inconveniencies as theſe, would be the certain events of the want of this diurnal motion of our globe. And as the reſt of the globes have their ſhares in the like motion, ſo we may very reaſonably imagine, that it is no leſs uſeful and beneficial to them than it is to us, and that the inconveniencies of the want of it would be as great.

## CHAP. IV.

### *Of the Annual or Periodical Motion of the Primary Planets.*

BESIDES the motion treated of in the preceding chapter, there is another, which is as clear a manifeſtation of the great Creator as that, namely, the periodical or annual, which is viſible in ſome of the great globes, and probable in many others. Among the fixt-ſtars it is highly probable ſomething of this nature is: as appears from thoſe new ſtars which I have before taken notice of, which, as I have ſaid, ſometimes become viſible to us, in one part of their orbits, and again diſappear in other parts of them. But theſe ſyſtems being out of the reach of our beſt glaſſes, I ſhall paſs them by, eſpecially becauſe in our own ſolar ſyſtem we have abundantly enough to entertain us in this demonſtration of God.

For it is very viſible, without the help of the teleſcope, that every planet of the ſolar ſyſtem hath this periodic motion I am ſpeaking of. For it is manifeſt, that either the Sun, and the planets move about the earth, the one in the ſpace of a year, and the reſt in other times; or that the earth and the other planets move about the Sun in ſuch times. But let us (as I have all along done) ſuppoſe the latter, that the Sun is fixt in the centre, without any other but its diurnal rotation in 25$\frac{1}{4}$ days: in this caſe we ſhall have the ſeveral primary planets revolving round the Sun in an excellent and due order, by the exacteſt rules of ſuch a noble ſtructure, ſuch an admirable œconomy, and that is ‘in times (as I ſaid) in ſquare proportion to the cubes of their diſtances.’ So that we ſee Mercury to perform its period in near 88 days: Venus (the next in order to the Sun) its period in ſomewhat above 224 days: then the earth, with its companion the Moon, in 365 days and one fourth: then Mars in about 687 days: next him Jupiter in about 4333 days: and laſtly Saturn in ſomewhat above 10759 days.

To this ſo ſtrict an order of the periods of thoſe planets, we may add the conſideration of the different paths of their periodical and diurnal motion: that they lie not in a very different plane, as quite acroſs, or the like; nor exactly in the ſame plane, but a little croſſing one another; the diurnal courſe lying in, or parallel to the Equator; but the other in the broad path of the Zodiac at an inclination of 23 one half degrees.

And a glorious contrivance this is for the good of our globe, and doubtleſs for all the reſt that ſympathize in the like motion. For was the earth's periodic motion to be always in the ſame plane with that of the diurnal, we might indeed be ſometimes nearer to, and ſometimes farther from the Sun; but at the ſame time miſs of thoſe kindly increaſes of day and night, together with ſuch uſeful directions of the Sun-beams, which the advances of the earth to one or other of the poles cauſe *: which two

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* There are two cauſes of the great difference between the winter and ſummer, heat and cold. One is the ſhorter or longer continuance of the Sun above the horizon: in ſummer long, which increaſeth the heat, as much as it lengthens the day: in winter ſhort, which diminiſhes the heat, as it ſhortens the day; and augments the cold, as it lengthens the night. The other cauſe is the oblique perpendicular direction of the Sun's rays, the oblique being weaker than the perpendicular; as is evident from Galilaeo's experiment, in his ſyſtem. Mun. Dial. 1. by holding a paper turned up at right angles, or a book half open, over-againſt an illuminated white wall; where it may be obſerved, that the ſide oppoſite to the wall, which the rays ſtrike perpendicularly, is far more light and white than the other ſide, on which the rays fall obliquely. The ſame it is in the incidence of the Sun's rays on any plane, namely, the rays are ſo much ſtronger, and the plane the more warmed and enlightened, as the rays are more or leſs perpendicular; and that on two accounts; 1. Be-

things are the real cauſes of our ſeaſons of ſummer and winter, ſpring and autumn, and not our being nearer unto, or farther from the Sun. For thoſe benefits, we at leaſt that inhabit towards the Northern Pole, have at the contrary ſeaſon, when

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cauſe the perpendicular rays ſtrike with greater force than the oblique. As in Fig. 4. the rays R R ſtrike the plane A P more forcibly than the plane O B. The action or force of which percuſſion is (like that of all other impulſes) as the ſine of the angle of incidence. So the force of the rays R R upon the oblique plane O B, is as the ſine only of R O B, whereas their force upon A P is as the whole ſine of 90 degrees, or angle R O P. 2. Another reaſon is, that a greater number, or quantity of rays, fall within the compaſs or area of any plane, in a perpendicular, than oblique direction. This will be manifeſt from the bare inſpection of Fig. 4. Where it may be obſerved, that all the rays between R R and O p fall on the plane A P; but only about one half of them would fall upon an oblique plane of the ſame length, if it was O b; or (which is the ſame thing) near as many rays would fall off O b, turned up to O b, as fall upon it. Alſo it may be obſerved farther, that as the line O B is longer than O p, ſo are the ſpaces between the rays larger in O B than O p; and conſequently fewer rays fall on O B for its length, than on O p for its length, or the rays are denſer, or more compact in O p than O B. And when they are ſo, they are ſo much the ſtronger, as is evident from the collecting and condenſing the Sun's rays by a burning glaſs.

What the particular power of the Sun's rays is in all directions, quantities, and impulſes, falls under mathematical calculation; but I need not trouble the reader with it, but ſhall refer to the ingenious Dr Wolfius, Mathematical profeſſor of Hall, his elementa Aerometriæ. And as for the proportional degree of the Sun's heat in all latitudes, and its altitudes, our moſt acute Savilian Profeſſor, Dr Halley, hath given us a neat and clear method for computing it in Philoſ. Tranſact. No. 203.

we have moſt need of them, *viz.* the Sun's proximity in winter; its greater diſtance from us in ſummer; as is manifeſt from the increment of its apparent diameter in winter to 32 minutes, 47 ſeconds, and the decrement thereof in ſummer to 31 minutes, 30 ſeconds. [*]

And now for a concluſion of this chapter concerning the periodic motions of the primary planets, we may take up the argument of Hugo de St Victore [†], "Who commandeth the Sun to "deſcend through the winter ſigns? And who "again cauſeth him to aſcend through the ſummer ſigns? Who leads him from eaſt to weſt?

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[*] Monſieur de la Hire, in his Tabul. Aſtron. makes the Sun's ſemidiameters to be Dec. 30. 16 minutes 22 ſeconds, and June 30. 15 minutes 49 ſeconds. But Mr Flamſteed, in his Lunar Tables added to Mr Horrox's Poſthumous works, makes the greateſt to be 16 minutes 23 ſeconds, the leaſt 15 minutes 50 ſeconds; and the French Academiſts 16 minutes, 23 ſeconds; and 15 minutes, 50 ſeconds. Vid. Recueil d' Obſerv. les Elemens d' Aſtron. p. 22.

Beſides the alteration of the Sun's apparent diameter, its ſwifter motion in winter about the ſolſtice by about a 15th part, is an argument of its being then nearer the earth. From whence it comes to paſs, that from the Vernal to the Autumnal Æquinox, there are about 8 days more, than from the Autumnal to the Vernal.

[†] Quis ſolem per hyberna deſcendere ſigna praecipit? Quis rurſum per aeſtiva ſigna aſcendere facit? Quis eum ab oriente in occidentem ducit? Quis iterum ab occidente in orientem revehit? Haec cuncta ſunt mirabilia, ſed ſoli Deo poſſibilia. Didaſcal. lib. vii. cap. 8.

" and who again brings him back from the weſt
" to eaſt? All theſe things are very wonderful,
" but to God alone poſſible."

## CHAP. V.

### *Of the Periodical Motion of the Secondary Planets.*

HAVING conſidered the periods of the primary planets, let us next caſt our eye upon thoſe of their ſecondaries. And among theſe we ſhall find the ſame complete order and harmony as among the laſt. Thus Saturn's five moons and Jupiter's four, and our own about the earth, have each of them their determinate times, ſome longer, ſome ſhorter intervals of time, in the ſame due proportion, as I ſpake of among the primaries.

Beſides which, there is another thing very conſiderable in this periodical motion of thoſe ſecondary planets, and that is, that it is mixed with a kind of cochleous direction towards one or other pole of the primary planets; by which means every ſatellite, by gentle degrees, makes its viſits towards each pole of its primary. This is well known among the Circumjovials, for inſtance, that they all have a ſlow and gradual ſcrew-like progreſs, firſt towards one, then back again towards the other pole of Jupiter: and that each ſatellite hath its declination greater and greater, according as it is farther or farther from Jupiter's body. Accordingly the declination of each Circumjovial, aſſigned by the diligent and ſagacious Caſſini *, after twelve years obſervations, are theſe. The greateſt declination of the firſt, or neareſt, exceeds not a third part of Jupiter's ſemidiameter: that of the ſecond, ſurpaſſeth but a little of a quarter of its diameter: that of the third a little exceeds three quarters of the diameter: and that of the fourth or outermoſt goes beyond Jupiter's poles by a third part of the ſemidiameter. All which mutations, he ſaith, are performed in the ſpace of 12 years. Thus the famous Caſſini. But I have myſelf obſerved a greater vagation in the third Satellite; that it advanced near to, if not even with the very limb or pole of Jupiter, and that its ſtay in Jupiter's ſhadow, or the duration of its eclipſe at that time, was leſs than is commonly aſſigned unto it, as it is reaſonable to imagine it ſhould be, becauſe the Satellite had only the outſide of the cone of Jupiter's ſhadow, and

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* Les Hypoth. et les Tables de Satel. de Jupiter, § 4. in the French Academiſt's large Collection.

conſequently a leſſer part thereof to paſs through at that time.

As to the end and uſe of this ſo obſervable a tendency in the ſecondaries towards each pole of their primaries, we may gueſs at it from what hath been ſaid of the like tendency of their primaries towards the Sun, on which our ſeaſons do depend: ſo thoſe ſecondaries moving in like manner to each pole, effect ſome of the grand works of the Divine Providence from pole to pole, illuminate all parts of their reſpective globes, contract the length of their nights, (as ſhall be ſhewn in a proper place), move their waters, and excite their tides, and perform other ſuch great works of nature, as with good reaſon, we attribute to the influx of our Moon here in our own globe.

And can ſuch well-contrived, ſuch uſeful motions, that the world could not ſubſiſt without, that nature could not do its grand works without, can theſe be other, than the *fiat* of an infinitely indulgent, as well as wiſe Creator! Could this conſonancy be ſo univerſal, among all the globes that fall within our view? Could their periods, and diſtances, be in the ſame due proportion all the univerſe over, their motions all ſo alike, had they not had the ſame Contriver and Maker! But I ſhall cloſe this argument with the reflection of the moſt ingenious Mr Molyneux*, who ſpeaking of the ſeſquiplicate proportion of both the primary and ſecondary planets, thus concludes: "And from hence we may juſtly fall into "the deepeſt admiration, that one and the ſame "law of motion ſhould be obſerved in bodies ſo "vaſtly diſtant from each other, and which ſeem "to have no dependence or correſpondence with "each other. This doth moſt evidently demon"ſtrate, that they were all at firſt put into motion "by one and the ſame unerring hand, even the "infinite power and wiſdom of God, who hath "fixed this order among them all, and hath eſta"bliſhed a law which they cannot tranſgreſs. "Chance or dull matter could never produce ſuch "an harmonious regularity in the motion of bo"dies ſo vaſtly diſtant: this plainly ſhews a de"ſign and intention in the firſt Mover. And "with ſubmiſſion to the reverend and learned Di"vines, I am apt to think, that one argument "drawn from the order, beauty, and deſign of "things, is more forcible againſt Atheiſm, than "multitudes of notional proofs." Thus Mr Molyneux. But we ſhall find farther evidences of this ſupreme management in theſe matters, from what follows in the next chapter.

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* Diopt. Nov. Par. 2. chap. vi. § 12.

## CHAP. VI.

### The Conſtancy and Regularity of all the Motions of the Earth and Heavens.

THAT the earth and heavens move at all, but eſpecially that they have ſuch particular and beneficial motions, appears, from the preceding chapters, to be the work of God. And the concurrence of the ſame infinite hand is as manifeſt in the perpetuity, conſtancy, and regularity of thoſe motions. For without this Almighty Guide and Manager, how is it poſſible that all thoſe vaſt and unwieldy maſſes ſhould continue their beneficial motions throughout all ages? ſhould perform their uſeful ſtages, without any the leaſt intermiſſion, interruption or diſorder that we know of? What motion, what contrivance, what piece of clock-work was there ever under the whole heavens, that ever came up to ſuch a perfection, and that had not ſome ſtops or ſome deviations, and many imperfections? But yet none was ever ſo ſtupid as to conclude ſuch a machine (though never ſo imperfect) was made by any other than ſome rational being, ſome artiſt that had ſkill enough for ſuch a work. As he in Cicero[*] argues, from his friend Poſidonius' piece of watch-work, that ſhewed the motions of the Sun, Moon, and five Erratics; that if it had been carried among the Scythians or Britains, *Quis in illa barbarie dubitet, quin ea Sphaera ſit perfecta ratione?* with more to the ſame purpoſe: no man even in that ſtate of barbarity would make any doubt, whether it was the workmanſhip of reaſon or no[†]. And is there leſs reaſon to imagine thoſe motions I have been treating of to be other than the works of God, which are infinitely more conſtant and regular than thoſe of man? Or, to uſe the laſt mentioned Stoic's argument, can it be thought that Archimedes was able "to do more in imitating the motions of the heavens (in his ſphere), than nature "in effecting them?"

And now to reflect upon the whole, and ſo conclude what hath been ſaid concerning theſe ſeveral motions: We may all along perceive in them ſuch manifeſt ſignals of a divine hand, that they all ſeem, as it were, to conſpire in the demonſtration of their infinite Creator or Orderer. For beſides what in all probability is in other parts of the Univerſe, we have a whole ſyſtem of our own, manifeſtly proclaiming the workmanſhip of its Maker. For we have not thoſe vaſt and unwieldy maſſes of the Sun, and its planets, dropt here and there at random, and moving about the great expanſum, in uncertain paths, and at fortuitous rates and meaſures, but in the completeſt manner, and according to the ſtricteſt rules of order and harmony; ſo as to anſwer the great ends of their creation, and the divine providence; to diſpatch the noble offices of the ſeveral globes; to perform the great works of nature in them: to comfort and cheriſh every thing reſiding on them, by thoſe uſeful changes of day and night, and the ſeveral ſeaſons of the year.

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[*] De Nat. Deor. l. ii. c. 34.

[†] See the place cited at large in my Phyſico-Theology, p. 2.

Theſe things are ſo evident to the reaſon of all men, that Tully might well make his Stoic to alledge this as one of his principal arguments for the proof of a Deity *: "The fourth cauſe, ſaith "he, and that even the chief, is the equality of "the motion, and the revolution of the heavens; "the diſtinction, utility, beauty and order of the "Sun, Moon, and all the ſtars; the bare view "alone of which things is ſufficient to demon"ſtrate them to be no works of chance. As if

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* De Nat. Deor. lib. ii. cap. 5.

“ any one ſhould come into an houſe, Gymnaſium,
“ or Forum; when he ſhould ſee the order,
“ manner, and management of every thing, he
“ could never judge theſe things to be done without
“ an efficient, but muſt imagine there was
“ ſome being preſiding over them, and whoſe
“ orders they obeyed. So much more in ſo great
“ motions, ſuch viciſſitudes, and the orders of
“ ſo many and great things;—a man cannot but
“ conclude, that ſuch great acts of nature are governed
“ by ſome Mind,” ſome intelligent Being.

And ſo again afterwards (Chap. 21.), when, among other things, he had been ſpeaking of the motions of the planets, he thus argues, “ I cannot
“ poſſibly underſtand, ſaith he, how all this
“ conſtancy can be among the ſtars; this ſo great
“ agreement of times through all eternity, among
“ ſuch various courſes (how this can be) without
“ ſome mind, reaſon and counſel.” And a little after this, ſpeaking of the fixt-ſtars, he ſaith, “ But
“ the perennial, and perpetual courſes of thoſe
“ ſtars, together with their admirable and incredible
“ conſtancy, declare a divine power and
“ mind to be in them.” And this he takes to be ſo plain a caſe, that he who could not diſcern it,

he thinks could diſcern nothing. And then he thus concludes: "In the heavens then, there is "neither any chance, nor any temerity, nor error, "or vanity; but, on the contrary, there is all or"der, truth or exactneſs, reaſon and conſtancy. "And ſuch things as are void of theſe are coun"terfeit, falſe, and full of error.——He therefore "that thinks the admirable celeſtial order, and "incredible conſtancy, on which the conſerva"tion, and good of all things depend, to be void "of a mind, he himſelf deſerves to be accounted "devoid of a mind." Thus with great force and reaſon, Tully's Stoic rightly infers the preſence and concurrence of a Divine Being, and Power, from the motions of the heavens: only not being aware who that Being was, he erroneouſly imagines the heavenly bodies themſelves to have Divinity, and puts them therefore into the number of the Gods; which error is excellently refuted by Lactantius, in his Inſtit. Divin. lib. ii. cap. 5. *etc.*

# BOOK V.

## Of the FIGURE of the ſeveral GLOBES of the UNIVERSE.

### CHAP. I.

### *The Conſonancy of all the Globes in their Spherical Figure.*

HAVING, in the preceding book, manifeſted the motion of the earth and heavens to be the contrivance and work of God, I ſhall inquire in this, whether their figure be of the ſame kind, wiſely ſuited to the motions, and in a word, to the whole ſtate and convenience of the ſeveral globes, ſo as to manifeſt itſelf to be the work of God?

Now as to the figure; it is obſervable in the first place, that there is a great conſent therein, among all the globes that fall under our view; and that is, that they are all ſpherical, or nearly ſo, namely ſpheroidal *. Thus all the fixt-ſtars, ſo far as we are able to behold them, either with our naked eye, or our glaſſes. Thus the Sun, and thus all its planets, and thus the ſecondaries, or moons accompanying Saturn, Jupiter, and our Earth. And although Venus, Mercury, and our Moon have phaſes, and appear ſometimes falcated, ſometimes gibbous, and ſometimes more or leſs round, and even Mars too, in its quadratures, becomes gibboſe; yet at ſuch times as theſe planets ſhew their full phaſes, they are found to be ſpherical, and only loſe this figure by virtue of their poſition to the Sun, to whom they owe their light. And this ſphericity, or rotundity, is manifeſt in our Moon, yea, and in Venus [*] too; in whoſe greateſt falcations the dark part of their globes may be perceived, exhibiting themſelves under the appearance of a dull and ruſty colour.

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* See Phyſico-Theol. Book 2. c. i. Note *a*.

And as this ſpherical figure holds in every of the globes at a diſtance from us, ſo we may reaſonably imagine our own globe to be conſonant to the reſt. But indeed we have great reaſon to conclude it to be ſo from the curvity of its ſhadow in its eclipſes of the Moon; from the diſcovery of new conſtellations in the heavens, as we change our hemiſphere, and make approaches towards either pole; from the ſurface of the ſea, which appears to be of this figure, by our gradually diſcerning far diſtant objects, mountains, towers, ſails of ſhips, *etc.* the parts of which are more and more ſeen, as we approach nearer to them: with other arguments to the ſame purpoſe, which I need not enumerate in a caſe now generally owned to be true.

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[*] What I have here affirmed of the ſecondary light of Venus, I have been called to an account for, by an ingenious Aſtronomer of my acquaintance. But I particularly remember, that as I was viewing Venus ſome years ago, with a good 34 foot glaſs. when ſhe was in her perigee, and much horned, that I could ſee the darkened part of her globe, as we do that of the Moon ſoon after her change. And imagining that in the laſt total eclipſe of the Sun, the ſame might be diſcerned, I deſired a very curious obſerver that was with me, and looked through an excellent glaſs, to take notice of it, who affirmed that he ſaw it very plainly.

## CHAP. II.

### *Of the Inequalities, or Hills and Valleys obſervable in the Earth and Moon.*

HAVING, in the preceding chapter, demonſtrated the ſeveral globes of the Univerſe to be ſpherical, it is not to be underſtood that theſe globes are ſtrictly ſo, but an allowance is perhaps to be made for the difference between their æquatorial and polar diameters, before ſpoken of: but eſpecially for thoſe little and inconſiderable excreſcences of hills, very manifeſtly diſcernible in the Moon *, as well as in our own globe;

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* Every one that hath viewed the Moon with but an ordinary glaſs, eſpecially, when ſhe is not round, may eaſily perceive conſiderable unevenneſſes; that ſome parts are manifeſtly higher, and others lower. About the quarters, divers bright golden ſpots may be ſeen in the ſhaded part, at ſome diſtance from the enlightned part; and theſe may be perceived to grow larger and brighter, as the ſhady part turns more and more towards the Sun; till at laſt you may ſee all the intermediate valleys between thoſe ſpots, and the other enlightened parts. Alſo in divers parts of the Moon, eſpecially ſuch as border on the ſhaded part, there may be obſerved to be certain holes or pits, black, dark, or ſhady, when the parts encompaſſing them are illuſtrious and bright. And this darkneſs, as if under ſome mountain, lies always on the ſide next the Sun, and gradually goes off as the hole, pit or valley is enlightened, and looks like a depreſſed ground in the body of the Moon. All which things are manifeſt ſignals that the Moon's ſurface is not even and ſmooth, but like that of the earth, full of hills and valleys.

Which opinion, although now well grounded on ocular demonſtration, was as old or older than Plutarch's days, who in his book *de Facie in orbe Luna*, at the beginning, cites it as Clearchus' opinion, Εικονας εσοπτρικας ειναι τα ειδωλα της μεγαλης θαλασσης—i. e. That which is called the face of the Moon, are the images and appearances of the great ſea in the Moon. And about the middle of that tract; Τὸ δε φαινομενον τουτὶ προσωπον—i. e. As to that face which appears in the Moon: as our earth hath certain large bays; ſo we conceive the Moon is overſpread with large hollows and ruptures, containing water, or a thick dark air, into which the Sun-beams are not able to enter, and ſo no reflection is made by them.

As to other matters in which the Earth and Moon ſeem to agree, as in ſeas, and great collections of waters, an atmoſphere, *etc.* I ſhall paſs them by here, as improper for this place.

which I call little and inconſiderable, eſpecially thoſe in the earth, becauſe they are ſo in proportion to the earth's diameter; as will appear by coming to particulars. The diameter of the terraqueous globe I have ſhewn in my Phyſico-Theology * to be about 7935 Engliſh miles, and in this book to be † 7967 miles: but that of the hills is no more than a few miles. Snowdon in Caernarvonſhire (the higheſt mountain in all our iſland) is but 1247 yards ‡; the Alps themſelves but about two Engliſh miles ‖: nay, the very Pike of Tenariffe, one of the higheſt ridges through-

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* Book 2. cap. ii. Note.

† Book 1. cap. ii. Note *a*.

‡ In the Journal of the late ingenious Richard Townley Eſq; of Townley in Lancaſhire, I find this Note upon Sept. 6. 1682. This day Mr Adams called here, who is taking a ſurvey, *etc.* He told us, that with repeated trials he had found Snowdon-hill 1320 yards higher than the high-water mark, and that the quickſilver ſtood at the bottom at 29 inches; at the top of the hill 25'96: ſo that 1320 gave 3'04. Then follows this note, *viz.* Mr Adams coming ſince tells me, that the height of Snowdon was but 1247 yards, which gave 3'03.

The reaſon of this difference of 73 yards, in the height of Snowdon, I take to be, that the firſt meaſure was made by Mr Adams himſelf, the latter by Mr Caſewell with Mr Adams' inſtruments: and probably the former is the height above the ſea, the latter only above ſome plane.

‖ Mr Nic. Facio told me, that he had meaſured the height of the Montagne Mauditi, which is one of the higheſt ridges of the Alps, and that he found it to be 2000 French Toiſes above the lake of Geneva, which is equal to 12816 Engliſh feet, or 2'42 miles.

out the globe, unleſs we except the high mountains of Peru, called by Joſ. Acoſta[†] Periacaca; or that near St Martha[‡]; or thoſe called the Andes[‖]; this ridge (I ſay) is computed to be but between 3 and 4 miles perpendicularly above the ſea[*]. All which eminencies, compared with the diameter, or ſemidiameter of the earth, is no more than as a particle of duſt is to a large globe, on which it reſteth.

And ſo likewiſe for the mountains viſible in the Moon, although ſome of them are of that height[§], as to reflect the light of the Sun from their lofty tops ſome days before ever it reacheth the valleys beneath them, yet on the Moon's limb we can

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[†] Acoſta ſaith, the Alps ſeemed to theſe mountains he travelled over but as ordinary houſes to lofty towers. See my Phyſico Theol. Book 1. chap. 1. Note *b*.

[‡] Capt. Dampier ſaith, that he was of opinion, that the hill near St Martha is higher than the Pike of Tenariffe. Voyage round the world. p. 24.

[‖] Of the Andes of Chili and Peru, Capt. Dampier ſaith, Theſe are the higheſt mountains I ever ſaw, far ſurpaſſing the Pike of Tenariffe, or Santa Martha, and I believe any mountains in the world. ibid. p. 95.

[*] See Dr Hook's account of the Pike of Tenariffe; from his friend Dr G. T. who went to the top of it; at the end of his lectures concerning ſprings. p. 42.

[§] By Riccioli's meaſures, the height of what he calls mount Sinai, or St Katherine's hill, is 9 Bononian miles, and that of Xaverius 12; but according to his corrections, the former is but 8 miles and fourteen 25ths, the latter 11 and one half. Which at the rate of 6020 Engliſh feet in a Bononian mile, is about 13 and 9 Engliſh miles; an height ſo great, conſidering how much the Moon is leſs than the Earth, that I cannot but think that diligent perſon was miſtaken in his meaſures, and that the computations of Hevelius are much the beſt: who, as he was as able as any man, and

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made more accurate and diligent obſervations of the Moon's face than moſt men ever did; ſo he was more likely to come neareſt the truth. And by his reckoning, the higheſt hills in the Moon are but about three quarters of a German mile; and ſome of them but ſeven ſixteenths; and ſome not above one Italian mile. And conſidering the bulk of the Moon to that of the Earth, theſe are great eminencies for the Moon.

And as the lunar mountains are of ſo prodigious heights, ſo many of them are of great extent. Hevelius reckons the lunar Taurus to reach to 170 German miles; mount Sepher 150; and the lunar Apenine above 104 German miles.

The way how to meaſure the height of the mountains of the Moon, is not difficult, nor uncertain; which is by obſerving the diſtance between the diſtant golden ſpots, at their firſt appearance (which are the tops of hills) and the enlightened part of the Moon. Which diſtance may be computed by miles, or any other equal parts, into which we can imagine the Moon's diameter divided. Thus in Fig. 5. A R B is a part of the Moon's circumference, one part of which A R is enlightened, the other part R B is in darkneſs. H i is a mountain, whoſe top H is touched by the Sun-beams, ſhining from S the Sun to R, and reaching to H. Now ſuppoſing the ſemidiameter of the Moon R C, to be 274 German miles, according to Hevelius, the length of the ſide RH (or diſtance between the top of the hill, and the edge of the enlightened part) will be found alſo to be a 10th, 20th, or other part of that ſemidiameter or diameter; or ſome certain number of miles; and then we have the two ſides R C, 274 miles; and RH, and the right-angle included between them; by which, both the other angles, and the ſide C H, may be found by a common caſe of right-angled triangles. Out of whch ſide C H, deducting the Moon's ſemidiameter 274, there remaineth the heigth of the mountain H i. Conſult here Hevel. Selenogr. cap. viii. Galilæo Nunc. Sider. p. 14. Riccioli Almageſt. lib. iv. cap. 8. Schol.

diſcern nothing of them; but ſo far from that, that, on the contrary, the edge through our beſt glaſſes looks like an even, ſmooth, and uninterrupted circle *.

Although then vaſt mountains, when ſeen near at hand, ſeem to be very conſiderable excreſcences of our globe, yet ſince they are little, when compared to the globe itſelf, we may look upon our own, and all the reſt of the globes, as if they

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* The edge of the Moon, which I here mean, is that next the Sun; on which I could never perceive with my beſt glaſſes any the leaſt ſign of a mountain, but all to be exactly level and ſmooth. Only indeed there are ſome certain tranſient roughneſſes and unevenneſſes on the limb cauſed by vapours, eſpecially when the Moon is near the horizon, and in windy, and ſome other weather. At which times, the motion of the air and vapours, make a pretty criſpation and rolling, like waves on the Moon's limb, which have the appearance of moving mountains and valleys. But on the oppoſite ſide, if the leaſt portion of the darkened part of the Moon, extends beyond the enlightened part, mountains may very manifeſtly be diſcerned, exactly reſembling ours on the earth. A few hours before and after the full, I have with pleaſure ſeen the appearance of conſiderable mountains and bays. One of which views, I have given in fig. 6. which is the Moon's appearance, ſoon after the full, on Sept. 12. 1714. In which ſeveral riſings and depreſſions may be ſeen, and the tops of ſome of the mountains ſomewhat diſtant, are expreſſed by the little ſpots.

Theſe alone I conceive are mountains which the excellent Hevelius ſpeaks of in ſeveral places of his Selenography, particularly in his anſwer to Bettinus, and other Peripatetics, in chap. vi. p. 143. who denied that mountains could be in the Moon, as well as many other things diſcovered now by the teleſcope.

were perfect ſpheres, or at leaſt ſpheroids. And finding them to be ſuch, let us next inquire what reaſon there is to imagine this their form to have been the great Creator's work.

## CHAP. III.

### *The Univerſality and Uniformity of the Figure of the ſeveral Globes of the Univerſe is a ſign of their being the Work of* GOD, *not of Chance or Neceſſity.*

WHEN we ſee divers pieces of curious device and workmanſhip to bear the ſame marks of art, to have the ſame maſterly ſtrokes of painting, clock-work, architecture, *etc.* we conclude with great reaſon ſuch pieces were made by the ſame ſkilful hand. So when we ſee the ſame commodious ſpherical figure to be imparted to the earth, and all the heavenly bodies, we have as good reaſon to conclude them to be pieces of the ſame hand, contrivances and works of the ſame ſkilful Architect. For if the Univerſe had been a work of chance, all the ſeveral globes would have been of ſeveral forms, one of this, another of a quite different figure; one ſquare, another multangular, another long, and another of another ſhape. Or if all the ſeveral globes had been a work of neceſſity, and their figure had been owing to the natural tendency, or gravity of matter, *viz.* that the ſelf-attracting power of matter did make all the ſolids and fluids of all the ſeveral globes as naturally run into a globoſe form, as a drop of quickſilver doth: yet ſtill we may demand, how came matter by this ſo commodious a power? What made it to affect ſo proper a form, but the infinite Creator's *fiat?*

But not to conteſt that point, but granting gravity to be congenial and coeval with matter, without inquiring how it came by that power, and allowing that every globe of the Univerſe had its form from the ſelf-attracting power of its matter, yet ſtill we have undeniable marks of final cauſes, of wiſe order, and an over-ruling power in the caſe. For let us imagine our terraqueous globe in its chaotic ſtate; all its matter, every particle of it divided, and floating about, and ready, by its ſelf-attraction, to run together into its natural form, that of a globe: in this hurly burly, this jumble of unguided nature, made by attraction only, a confuſed globoſe maſs can be ſuppoſed to be formed; but without any order, without that convenient lodgement of its parts, as the neceſſities of an habitable world require. But inſtead of any ſuch ſigns of diſorder, or of nature's acting with an unguided power, we have the clean contrary; all the ſignals of a wiſe contrivance, and excellent art; as will appear in the following chapter.

## CHAP. IV.

### *The terraqueous and other Globes appear to be the Work of* GOD, *from the wiſe Diſpoſition of their Parts.*

AS the earth, and all the other globes would have been of various forms, if they had been made by chance, or would have been confuſed maſſes, if made by neceſſity, according to the laſt chapter: ſo in this I ſhall ſhew them to be the work of a wiſe and a kind Agent, from the commodious ſtructure and diſpoſition of their parts, ſo far as we have any knowledge of them. Thus the Moon hath great appearances of being no leſs commodiouſly, than the earth, divided into hills and valleys, (as I have ſet forth in the ſecond chapter); into dry lands, and great collections of waters[a], and to be encompaſſed with an atmoſphere as we are[b]. So Jupiter, although at ſo great a diſtance from us, hath manifeſtly, we ſee, his lighter and darker parts; his belts and ſpots darker than the reſt of his diſk. Theſe Mr Caſſini (who longer viewed this planet than any body elſe) takes to be canals containing ſome fluid matter, or water, that more weakly reflects the Sun's rays, than the other parts of the planet do, and that they have ſome reſemblance with what happens here upon earth. " For if, ſaith he *, one from on high, in the heavens, ſhould ſee the earth in ſome particular ſituations, the ſea, which encompaſſeth the earth, would appear very like the great ſouthern belt that encompaſſeth the whole globe of Jupiter: the Mediterranean ſea would make an appearance, not unlike thoſe belts which are interrupted or broken, which we ſee in this planet: the other ſeas would make thoſe great black ſpots, which never alter at all: the continents and iſles would ſeem like thoſe bright ſpots that are alſo permanent: the ſnows would make thoſe glittering ſparkles, (Brilliants), that from time to time diſappear: the flux and reflux of the Ocean, and thoſe great inundations that happen ſometimes here, would occaſion other ſpots to appear and diſappear: the Moon would reſemble

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[a] That there are ſeas, or great collections of waters in the Moon, is highly probable from the Moon's ſpots, which plainly ſeem to be water on theſe two accounts, 1. Becauſe thoſe ſpots appear to be in ſtrait and level long planes, when viewed about the Moon's quarters, or at ſuch times as one half of them are enlightened, the other half in darkneſs. In this caſe, when we do not look directly upon the planes, or ſee them wholly enlightened, but view them in a manner ſideways, their ſurfaces look as the ſea doth, when we view it from the ſhore, *viz.* a large level plane: only we may now and then diſcern a bright ſhining part ſtanding a little out of the large levels, which are, no doubt, certain rocks or iſlands in the midſt of thoſe ſeas. 2. The darkneſs of thoſe ſpots, more than other parts of the Moon, is an argument they are water, or ſome ſuch like fluid, which imbibes the Sun's rays more than harder bodies, and doth not therefore ſo vigorouſly reflect them as they do. Accordingly about the Moon's quarters, when thoſe ſpots, as I ſaid, have the appearance of long planes, we may obſerve their edge to be a kind of hazy border, which grows darker and darker, as the rays are more and more abſorbed.

But indeed hard bodies, if they have ſmooth ſurfaces, although they reflect ſtrongly to one place, yet in other places they are leſs viſible. Thus a looking-glaſs, a diamond, *etc.* reflect vigorouſly the Sun's rays towards one part, ſo as to dazzle the eyes; but in other parts, they appear of a dark, blackiſh hue. Which by the by, is the reaſon why jewellers grind their diamonds with many ſides and angles, that their luſtre may appear many ways. So ſilver (as Galilaeo obſerves, Dial. 1.) when boiled only in argol and ſalt, appears as white as ſnow; but where ever it is burniſhed, it becomes obſcure. And ſo he tells us, rightly enough, the Moon would become inviſible to us, if its ſurface was not rough, but ſleek and ſmooth. See alſo Hevelii Selenogr. chap. v. p. 151.

[b] That there is an atmoſphere about the Moon, ſee book vii. chap. 3. note 1.

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* Nouvelles Decouvertes de Jupiter; par M Caſſini, in the Memoires de Mathem. et de Phyſique for January 1692.

one of Jupiter's ſatellites: in fine, the clouds of our atmoſphere would reſemble thoſe broken interrupted belts, and thoſe tranſitory ſpots, which often change their ſize and figure, and have motions of different velocities."

Thus that ingenious, and curious obſerver. According to whoſe, not improbable opinion, this planet Jupiter hath all its parts orderly placed, as is here upon earth.

And ſo for the reſt of the planets, whoſe faces exhibit different appearances, of brighter and darker parts, as Mars and Venus particularly do *, it is highly probable that there may be ſuch a diſtribution, ſuch an allotment of parts, as thoſe in Jupiter, and which are more plainly viſible in our own globe.

Which brings me to ſpeak particularly of our own globe, of which we have a nearer view, and can plainly ſee the footſteps of divine Providence, in the wiſe and orderly diſpoſition of all its parts; which are ſo diſtributed, ſo placed, as may beſt miniſter to the ſeveral uſes and conveniencies of an habitable world. Thus for inſtance, the two grand parts, the ſolids, and the fluids of the terraqueous globe, inſtead of being jumbled into one maſs, are admirably parted, and as nicely laid in proper pla-

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* See book iv. chap. 2.

ces. The earth depoſited in uſeful ſtrata; ſome for the ſervice of the vegetable kingdom; ſome for the generation and nouriſhment of minerals and metals; ſome for that of ſtones and foſſils; and ſome for the ſweetening and conveyance of the waters. And here it is remarkable, and an argument of wiſe deſign and appointment, That all thoſe ſeveral ſtrata, or beds, are lodged at proper and convenient depths, and diſtances from the ſurface; that for vegetables, the uppermoſt, for every man to cultivate; and this divided into various ſoils, and moulds, for all the varieties of trees and plants; thoſe ſtrata, that contain the minerals, metals, and foſſils, at ſuch depths, as to be out of the way, when they may encumber, or hurt us; but may be come at by us, when we have occaſion for them. And as for thoſe ſtrata that convey the ſweet waters *, it is very remarkable, that they are ſo univerſal, in all, or moſt parts of the world; that they conſiſt of ſuch proper pervious matter; that they remain ſo diſtinct from, and unmixed with the other ſtrata; and that they lie at ſuch due depths, as either to break out into fountains, or to be dug into, for wells. But I ſhall not enlarge on theſe matters, having ſpoken of them elſewhere.

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* See Phyſico-Theol. Book iii. chap. 2.

And as this ſo commodious a diſtribution of the earth, ſo that of the waters is a manifeſt demonſtration of the concern of a wiſe Agent, although we ſhould aſcribe all that is poſſible to be aſcribed, to the neceſſities of nature in the formation of the world. For the waters, if we obſerve them well, are accurately diſperſed, and lodged about the world, for the proper offices thereof, in ſeas, in lakes, in rivers, and in fountains, to ſatisfy the thirſt of animals, to afford them ſome part of their food, and to miniſter abundant ſupplies of vapours for the clouds, the rains, and winds: which ſupplies muſt either have failed, or been too abundant, or have been attended with ſome or other great inconvenience, without ſuch a commodious intermixture of the land and waters.

This Συναγωγη, as the LXX tranſlate it, this orderly gathering together of the waters, is implied in Moſes's relation of the branch of this creation, Gen. i. 9. “ And God ſaid, Let the waters under “ the heaven be gathered together unto one place.” Where the Hebrew word *Ikkavu* denotes a regular and orderly gathering of the waters, as if their allotment had been made, their receptacles had been marked out by a rule, or a plumb-line, by the Creator's *fiat*.

Thus it is demonſtratively plain, that the earth and waters were laid by a wiſe hand; and therefore whatever concern nature might have in giving a ſpherical figure to our globe, yet was the Creator the principal agent, the grand manager of the matter.

## CHAP. V.

### *The Convenience and Neceſſity of a Spherical Figure to the Good of the Globes, is an Argument they were the Work of* GOD.

BESIDES the orderly and commodious placing the parts of the ſeveral globes, ſpoken of in the laſt chapter, there are ſtill other reaſons to aſcribe the ſphaericity of our own and the other globes to a wiſe Agent. For beſides that this figure is the moſt agreeable to a world, as being the moſt capacious; and the moſt agreeable to a maſs in motion, as being at a due diſtance from the centre of motion and gravity; ſo without this figure there could have been no ſuch comfortable, and agreeable alterations of day and night, and heat and cold, as now there are, but ſome parts muſt have been, for too long a time, ſkreened from the kindly approaches of the Sun and Moon, and conſequently have lain under too long and uncomfortable a darkneſs, and been chilled with a miſerable cold. And as to our own globe, the winds could not have given thoſe kindly, and ſalutiferous agitations to the air, as they do, but they muſt have been too much retarded, if not wholly ſtopped by the exorbitant angles, and jettings out of other figures. And laſtly, the waters, which I ſhewed to be well intermixed with dry land, would have had intolerable confluences; one part too much, another none at all; no vapours, no fountains, no rivers: ſo that inſtead of an habitable, well ſtocked world, far the greateſt part would have been either a deſart, or an unneceſſary confluence of water.

Thus having made it evident, that particularly our own globe received its figure by the direction of the infinitely wiſe Architect of all things; we have reaſon, had we none beſides, to conclude the ſame of all the reſt of the globes of the Univerſe, in as much as they agree with ours in other things as well as in their figure, ſo far as we have any knowledge of them, and their ſtate. Thus the planets of the Solar Syſtem have their light from the Sun as well as we; they turn round on their own axes, and revolve round the Sun, and conſequently have their days and nights, their ſummers and winters, as well as we; they have their hills and valleys, as I ſaid, their land and waters, by all the ſigns that may be, as well as we; and therefore agreeing with our globe in ſo many of thoſe very things, wherein their figure is concerned, had we none of thoſe reaſons I have already mentioned, there would however be great reaſon to preſume the ſame thing of them, as of our earth, *viz.* that they received their figure from the ſame wiſe Creator, and that (were we near enough to behold them) they have as manifeſt ſignals of it as we have.

# BOOK VI.

## Of the ATTRACTION or GRAVITY of the Terraqueous, and other Globes.

### CHAP. I.

### *The Uſefulneſs of* ATTRACTION *in the Production and Preſervation of the Figure of the Earth, and the Deſcent of heavy Bodies.*

HAVING in the two laſt books treated of the motions and figure of the globes, I ſhall in this conſider their gravity or attraction, which, according to the modern philoſophy, (which hath great reaſon and probability on its ſide), hath a great agency in both theſe matters, both in effecting and preſerving the figure of the globes, and governing their motion.

As to the agency of the natural attraction of matter, in the production and preſervation of a ſphaerical figure, as that of the ſeveral globes is, beſides what hath been before ſuppoſed, it may be collected from the ſphaerical figure which moſt fluids take, when there is no obſtacle to hinder their doing ſo. Thus I have ſaid quickſilver manifeſtly doth, eſpecially in ſmall drops or quantities, in which caſe their own ſelf-attracting power is equal to, or exceeds that of the earth: ſo doth lead, and other metals, when in fluxion *; ſo doth water, oil, and in ſhort all liquids, which run nearly into a ſphaerical form, when hung on a ſmall ſurface, as at the point of a pin; or into an hemiſpherical figure, on a broader ſurface; their ſelf-attraction cauſing the former, as that of the earth, and ſurface on which they lie, doth the latter. Theſe phenomena have indeed been aſcribed to divers cauſes, moſt of them probable enough, except the preſſure of the incumbent air; but this is manifeſtly not the true cauſe, by reaſon the caſe is the very ſame in the air-pump (when

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* This is very manifeſt from the making of ſhot. The way of doing which, is by running the melted lead through a ladle full of holes into cold water. In doing which they take care, their lead be not too hot, becauſe the globules would then fly to pieces: nor too cold, becauſe it would then be long and have tails; but in a due temper it turns round. They put orpiment into their lead, when they melt and prepare it for ſhot.

the preſſure is taken off) as in the free air; and therefore ſome other cauſe is to be found: and what more probable, or ſo probable, as this gravity or attraction, which manifeſtly exerts itſelf in ſome, and is highly probable in all material things *? In the earth itſelf there is manifeſtly ſuch a thing as gravity, which might as well be the natural cauſe of the ſphaericity of our globe, as it is in that of leſſer maſſes; but then, as I demonſtrated in the laſt book, it is alſo evident, that an over-ruling power, and a wiſe providence, not only gave matter this gravitating power, but guided and managed it in the formation of the world.

And now, upon ſuppoſition that gravity had any thing to do in the production of this ſphaerical figure I am ſpeaking of; the ſame it muſt have alſo in the conſervation of that figure. For the ſame power it exerted at firſt, it retains ſtill; which is as neceſſary ſtill to the preventing and obviating all extravagant excurſions, and deviations from that figure, which may happen through extraordinary commotions and convulſions in any of the globes; ſuch as earthquakes are, and other ſuch

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* For the proof of this, I ſhall refer to Sir Iſaac Newton's Optics, Queſt. 13. of the ſecond edition, and in his Principia in many places, particularly Book 3. Prop. 5. 6. 7.

like furious concuſſions and emotions that ſometimes befal our own globe.

But leaving theſe conjectural matters, let us come to a more evident benefit of gravity, and that is, the natural tendency of all bodies to the centre of the globe: this is very manifeſt in our own globe. For whatſoever the decays are among earthly things, howſoever their forms are changed, yet their matter remaineth entire, and returneth again to its grand parent the earth: or to put it in Solomon's words, Eccl. i 4. "One generation "paſſeth away, and another generation cometh: "but the earth abideth for ever."

And an admirable proviſion this is for the perpetuity of the globe, and to continue the ſtate and hability thereof throughout all ages, which would otherwiſe waſte and decay, or run into the moſt irreparable and pernicious diſorders.

## CHAP. II.

### *The Guard which Gravity affords againſt the centrifugal force of the ſeveral Globes.*

UPON a ſuppoſition that every of the globes revolves round its own axis, (which I have ſufficiently proved in the fourth book), we ſhall find, beſides the benefits already ſpecified, another very great uſe of gravity to the good, yea, the very exiſtence of our own and other globes, and that is, the preſervation of their integrity againſt the centrifugal force of this their revolution, or diurnal motion. For without ſuch a band, as gravity, to keep their parts together, the whirling about of thoſe globes would ſhatter them into pieces, and diſſipate them abroad into the circumambient ſpace. Thus muſt it needs befal our own globe, which whirls about at the rate of above 1000 miles an hour[*], and is compoſed of earth and water, materials of much too looſe a texture, to prevent the diſſipation, which the centrifugal force of ſuch a rotation muſt neceſſarily occaſion, about the æquatorial parts; a rotation that would as eaſily throw off the parts of the earth, eſpecially the waters, as the whirling round of a wheel or a globe, would looſe the duſt and water lodged thereon. But by reaſon the gravitating power exceeds the centrifugal, as 2174 exceeds 7.54064[†], that is above 288 times;

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[*] The diameter of the earth being 7967.7 miles, according to Book I. cap. 2. note 1. the ambit thereof is 25031.4 miles, which being divided into 24 hours, makes the revolution to be at the rate of above 1043 miles an hour.

[†] This is the proportion or nearly ſo, of the gravitating to the centrifugal force of the Earth under the æquator, as may be computed from Sir Iſaac Newton's Princip. lib. iii. Prop. 19.

therefore all parts lie quiet and ſecure in their reſpective places, and enjoy all the benefits, which I ſhewed do accompany this motion, without any diſturbance from it. Thus is our own globe guarded by its gravity againſt the centrifugal force of its rotation. But this is far more remarkable in ſome of the other globes. Thus particularly in the Sun, whoſe ambit is, 2582873 miles, and whirls round once in about 25 ¼ days, and conſequently doth revolve at the rate of 4262 miles, in an hour *, which is above four times as faſt as the earth; this in a little time would endanger its diſſipation, without ſuch a proviſion as gravity is.

But what is this to the centrifugal force of Jupiter? whoſe bulk far exceeds our terraqueous ball, and whoſe rotation is performed in leſs than half the time. But from a computation of particulars, we will better eſtimate the matter. The diameter of Jupiter being 120653 miles, its circumference is 379043 miles: which revolving round in leſs than ten hours, is at the rate of

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* The Sun's diameter being 822148 miles, the numbers here aſſigned will naturally follow.

As to the Sun's gravity or attractive power, it is (by the calculation of my friend the acute and learned Dr Halley) to the Sun's centrifugal force, as 47000 to 1: The method for finding which, ſee in the laſt note of the following page.

38159 * miles an hour at its æquator. And if the denſity of every planet be proportional to its diſtance from the Sun, as is now with great reaſon imagined; that is, if thoſe planets neareſt the Sun, as Mercury and Venus, are proportionably denſer than thoſe more remote, as Jupiter and Saturn; then is the globe of Jupiter of a laxer texture than ours is, and in ſo much the greater danger therefore of being whirled to pieces by ſo rapid a motion as that planet manifeſtly hath, were not its parts kept cloſe together, and ſedate, by ſuch a band as gravity is †.

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* Jupiter's ambit being 379043 miles, and his revolution 9 hours, 56 minutes, or 596 minutes; the revolution in an hour is, by the Logarithms, thus.

| | |
|---|---|
| 596 minutes | 1.7752463 |
| 379043 miles | 5.5786884 |
| : : 60 minutes | 1.7781513 |
| | 7.3568307 |
| 38159 miles | 4.5815934 |

† The proportion of Jupiter's, or any other planets, or the Sun's gravity, to their centrifugal force, may be computed from the moſt ſagacious Sir Iſaac Newton's Princip. lib. iii. Prop. 8 & 19. But the before-commended Savilian profeſſor ſuggeſted to me this eaſier and quicker rule, for ſuch planets as have ſatellites, *viz.* The proportion of the centrifugal to the centripetal force, or gravity of any planet at its ſurface, is compounded of the ratio which the cube of the ſemidiameter of the planet hath to the cube of the diſtance of any of its ſatellites from the centre of that planet; and the ratio which the ſquare of the ſatellites periodic time

## CHAP. III.

### *Of the Power and Uſefulneſs of Gravity to retain the Planets in their Orbits.*

FOR a concluſion of this ſixth Book, I ſhall take notice of one more remarkable benefit of gravity, which is grounded upon the ſuppoſition of the truth of the Newtonian Philoſophy; which hath ſo good grounds, and great reaſon, I might ſay demonſtrations on its ſide, particularly in this matter, that admitting of it here, we ſhall diſcover another admirable work of the creation, and that is, the preventing the evagation of the planets, and the accurate retaining them within the due bounds of their orbits. That this is done by gravity, and that gravity and motion ſolve in the moſt complete manner, all the phaenomena of the planetary motions both primary and ſecondary, is abundantly made out by the wonderful

hath to the ſquares of the periodic time of the planet's revolution. Thus, for inſtance, the diſtance of Jupiter's outermoſt ſatellite being 253 ſemidiameters of Jupiter, and its period 16 days, 16 hours, 32 minutes, or 24032 minutes, and Jupiter's revolution 526 minutes; we ſhall find the gravity in Jupiter's ſurface to be to his centrifugal force in his Equator, as 1 to 9·96.

ſagacity of the great Sir Iſaac Newton; as may be ſeen in his Principia.

But before I come to the particular agency of gravity, it will be neceſſary to premiſe ſomething concerning its nature, and ſome of its properties, *viz.* That gravity is not terminated at the ſurface, but reaches to the very centre, and is extended to immenſe diſtances all round the centres of all the globes: by which means, the celeſtial bodies are enabled to have ſyſtems of leſſer globes revolving about them. For had the force of gravity determined at, or near the ſurface, (as it might have done, if intended only for the conſervation of the globes), in this caſe, all the bodies that were put in motion, and that were to paſs at ſome diſtance from them, would move on in a ſtrait not curved line, and be loſt in the great abyſs of ſpace. But the all-wiſe Creator hath, in his firſt production of matter, beſtowed upon it ſuch a property, as that every particle thereof hath a tendency towards every other particle. From whence it comes to paſs, that every body hath a gravitating power according to the ſolid content, or real quantity of its matter, and not according to its ſuperficies, or extenſion.

And this gravity of all bodies is obſerved, manifeſtly to decreaſe in proportion of the ſquare of their diſtances reciprocally; that is, at twice their diſtance, the force is but one fourth of what it was at a ſingle diſtance; and but a ninth, at thrice the diſtance, *etc.*

That this is ſo, is abundantly proved by the laſt commended Author; who by eſtabliſhing this one principle in philoſophy, hath fully explained the ſyſtem of the world, ſo far as relates to us, and to all the reſt of the planets, that regard the Sun as a centre, both primary and ſecondary.

What the cauſe of gravity is, Sir Iſaac Newton doth not pretend to aſſign, his deſign being not to engage himſelf in framing hypotheſes, but to explain the phaenomena by experiments only, and to raiſe his noble ſuperſtructure upon them. And therefore although the matters of fact, and the final cauſes are evident, I will not venture to ſay how it comes to paſs, that bodies act at ſuch immenſe diſtances upon one another; but chuſe rather to acquieſce in adoring the wiſdom and power of the GREAT AUTHOR of all things, who hath inſpirited the materials of which the world conſiſts, with ſuch an active quality, as ſerves not only to preſerve the globes themſelves entire, but to enable them to revolve about their luminous centre (from whence they have their light and heat) in orbs that are the moſt commodious, and alſo fixt and permanent.

Having thus premiſed what was neceſſary for the underſtanding the nature and properties of gravity, I ſhall proceed to conſider its agency in the planetary motions. And here we have divers things, which plainly demonſtrate theſe motions to be no matters of chance, but the works of an infinitely kind, as well as omnipotent and all-wiſe Agent.

I have already in Book 4. Chap. 2. taken notice, of the motion of the planets being made, not in lines tending from the centre to the circumference, or very obliquely thereto, but acroſs, or nearly perpendicular to the radii. Alſo that the motions, and orbits of the planets, do not tend contrary ways, or interfere with one another. That therefore which I ſhall ſpeak of here, concerning the planetary motions being the work of God, will be only ſo far as gravity is therein concerned. And,

1. It was a very notable proviſion to prevent the evagation of the planets, and keep them within due and proper bounds, to bridle and detain them with gravity, as with ſo many reins and bridles. For as the natural tendency of all impreſt motion is in ſtrait lines, ſo when motion was given to the planets, this motion (although as I ſaid it was artificially made, perpendicularly to the radii,

yet) would carry them quite away in their tangents, ſo that they would never return again. But being thus detained by gravity, another admirable proviſion is, that, 2. They are moved in orbs: which orbs are formed of a motion compounded of this rectilinear impulſe, impreſt upon the planets, and the tendency of their gravity to the centres. In which motion a third thing very remarkable is, that the impulſe or velocity which is imparted by the firſt mover to every planet, and the gravity of each planet, are ſo nearly equal to what is required to make a body deſcribe a circle, that the orbits of the planets are not very eccentrical, but nearly circular. As is particularly remarkable in Venus, and the earth; and more eſpecially in the whole ſyſtem of Jupiter's ſatellites. And an admirable work this is. For ſhould the velocity of any planet be double to what would make it move in a circle, the planet would go away *in infinitum*, without ever returning again in any orb whatſoever. Or ſhould one half of the velocity be taken away, the planet would deſcend obliquely towards the Sun, until it became four times nearer the Sun than before; and then aſcend again to its former place, deſcribing a very eccentrical orb. And by aſcending and deſcending alternately, it would be heated ſixteen times more at one time than another. Which uneven heat would make the planet unfit for habitation. And the ſame thing would happen, if the determination of its motion ſhould be altered, ſo as to become very oblique to the radius, drawn from the planet to the Sun. But theſe things being accurately adjuſted and contempered, make the whole ſyſtem to be a work of incomparable convenience and beauty; a work the beſt contrived for the benefit of the world's inhabitants, and to ſet forth the curioſity and ſkill of the infinite Workman.

It is manifeſt therefore, that the ſyſtem of the planets is not to be reckoned a matter of chance, or a thing owing to a neceſſity of nature, but the work of a kind and wiſe Agent. And that this is ſo, will be farther manifeſt from the caſe of comets, whoſe motions, directions, and orbs being utterly different from thoſe of the planets, demonſtrate the planetary ſyſtem to have been modelled by counſel, and not by a neceſſity of nature, or left to chance. For as for the motion of comets, it is ſo far from being always the ſame way, that they move ſometimes contrary to one another. And as for their planes and directions, they lie every way. And as for their orbs, they are exceedingly eccentrical. And, by the by, this eccentricity is an admirable contrivance of the Creator, to prevent the comets from diſturbing either the planets, or one another, by their mutual attractions. For by this means, they have a large ſufficient room to revolve in; and by aſcending to very great heights, above the ſyſtem of the planets, and ſpending almoſt all their time in the remote regions of the univerſe, at vaſt diſtances both from the planets, and from one another, they do not incommode either the planets, or themſelves; as otherwiſe they would have done, ſhould they have moved in the ſame plane with the planets. For had they done ſo, they would have been apt ſometimes to have come too near the planets, and have diſturbed their motions, and perhaps have daſhed upon them alſo. But all theſe circumſtances are ſo well adjuſted, and ſo wiſely regulated by the divine Providence, that the ſyſtem could not have been better contrived, either for convenience or beauty.

And now upon this highly probable, I might ſay phyſically certain theory, of gravity acting in the motion of the globes, we have another exquiſite nicety, in the works of the creation, that juſtly deſerves the greateſt admiration and praiſe; that among ſo many immenſe, moving maſſes, they ſhould all obſerve their due bounds, keep the moſt proper paths appointed for their convenience and good, and at all times anſwer the great ends to which they miniſter in the creation. Particularly, that the habitable globes ſhould always remain at ſuch due diſtances, and move in ſuch proper orbits, as are beſt for them. And that the comets too, ſhould at the ſame time paſs in paths utterly different, but yet ſuch, in all probability, as may render them alſo of very great uſe to ſome or other parts of the world; whether we look upon them as places of torment, (as hath been ſaid), or bodies appointed for the refreſhment and recruit of the Sun, or any of his planets, as Sir Iſaac Newton conjectureth in his Princip. lib. 3. Prop 41. 42.

And now from the conſideration of what I have ſhewn in this ſixth Book, to be either highly probable, or very certain, concerning gravity, we have another manifeſt demonſtration of the infinite Creator's wiſdom and care, and another cogent argument to excite the higheſt veneration and praiſe in his creatures.

# BOOK VII.

## Of the PROVISION made for LIGHT and HEAT throughout the UNIVERSE.

### CHAP. I.

### *Of the Light and Heat of the fixt Stars and Sun.*

AS *light* and *heat* are two of the moſt uſeful things in the univerſe, ſo the infinitely wiſe and kind Creator hath made an excellent proviſion for theſe things; in all probability, for every globe throughout the univerſe, but particularly for thoſe of our own ſyſtem. For it is very manifeſt, that every globe we ſee, doth ſhine with its own native, or with borrowed light. Even all thoſe immenſe bodies at the greateſt diſtance from us, the fixt ſtars, which I have before ſaid, are probably ſo many ſuns, it is light they manifeſtly dart as far as to our ſo diſtant globe, as well as what they emit for the enlightening, warming, and cheriſhing their own reſpective planets.

But I ſhall forbear to launch out into thoſe conjectural matters, and ſhall come nearer home, into our own ſyſtem, where we have enough to entertain our eye, to captivate our thoughts, and to excite our higheſt admiration of theſe magnificent works of God; whether we ſurvey the great fountain itſelf of our light and heat, the Sun, its due poſition, and its wonderful uſe to its planets; and the incomparable proviſions that are made to ſupply its abſence and greater diſtances from them.

And in the firſt place, as to the Sun itſelf; what power is there that the moſt extravagant fancy can imagine to itſelf, that could ever be able to make ſo prodigious a maſs of fire as the Sun is, but only the power of God's almighty hand? A body of ſo immenſe a bulk, as I have ſhewn it is, and of ſuch an exceſſive heat, that no greater a number of its rays, than what fall within the compaſs of a two or three inch burning glaſs, ſhall actually burn; and what fall within the compaſs of not many feet, ſhall far exceed the ſtrongeſt culinary fire in the earth: As is manifeſt from its almoſt inſtantaneous burning and vitrifying the moſt obdurate, incombuſtible bodies, ſuch as not only green wood, and white bodies, but alſo ſtones, bricks, metals, yea, gold itſelf, (the hardeſt of all metals to be wrought upon by fire), which yet is melted down in a few minutes *.

Thus the infinite power and wiſdom of God appear in the appointment and make of that immenſe body of fire, the Sun; a maſs wonderful, and worthy of its Maker, whether we conſider its immenſity, its exceſſive heat, or its abſolute neceſſity and great uſe to us, and to all the reſt of its ſyſtem. But we ſhall find yet farther evidences of the great Creator's work in the following chapter.

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* The famous burning-concave at Lyons, of 30 inches diameter, and others in France and Germany, of greater breadths, have been celebrated for their feats in burning, calcining and vitrifying, both metallic and other bodies. But I queſtion whether any of them have come up to the Burning Inſtrument contrived by and made for Sir Iſaac Newton, and by him preſented to the Royal Society. It conſiſts of 7 concave foiled glaſſes, each of them 12 inches diameter, which are all ſo placed, as to have their foci concur in one point. By which means the heat is ſo increaſed, as in a ſurpriſing manner, to perform the feats here mentioned, and many others ſurpaſſing them.

Having mentioned theſe Burning Concaves, it may be of uſe on ſeveral occaſions, and particularly for the cheap trying of experiments, to take notice of what was related to me by a perſon of very high quality: Who doing me the honour to talk with me about ſuch Concaves, told me, that in Germany one Mr Czhernhauſen, a Sileſian gentleman, made divers very large concaves with paſteboard; which were covered over with a kind of paſte or foil, that ſtrongly reflected the Sun's rays. But what their power was, he did not ſee.

## CHAP. II.

### *Of the due Poſition of the Diſtance of the Sun and its Planets.*

AS the infinite power and wiſdom of God appears in the appointment and make of the Sun, according to the preceding chapter; ſo in this I ſhall demonſtrate the ſame, from the due poſition of the Sun among his planets, and his due diſtance from each of them.

Now, here we may take it for granted, that the Sun is the fountain of the light and heat of all the planets, not only of the earth, but of the other planets, that move either about the Sun, or the earth. But whether the Sun be placed in the centre of its ſyſtem, or the earth be ſo, is of no great conſequence here to inquire. But I have all along ſuppoſed the former to be the moſt probable hypotheſis, and it ſeems to be ſtill more ſo, from the conſideration we are now upon, concerning the community of its light and heat to all the planets. For ſince it is manifeſt, that what light and heat the planets have, they receive from the Sun, it is far more likely that this their fountain of light, and heat, is placed in the common centre of them, and that they move round about it rather than it about them.

But be it ſo, or not ſo, it is however very certain, that all the planets are placed at ſuch a due and proper diſtance, from the Sun, that they receive the beneficial rays thereof, in a due manner and proportion. There is no great reaſon to doubt of this, among the planets that are at greater or leſſer diſtances from the Sun than we, becauſe we find a noble and ſolemn apparatus, anſwerable to their diſtances from the Sun; which I intend to ſpeak of hereafter. But as for our own terraqueous globe, we have ſufficient ſignals of the great care and counſel, that have been uſed in the due poſition, and diſtance thereof from the Sun. For as to its poſition to the Sun, I have heretofore ſhewn, that by the inclination of its axis, and its diurnal and periodical revolutions, all parts have a due ſhare of light and heat. And as for its diſtance, it is ſuch, as not only prevents the danger of its interfering with the other globes, as I have formerly obſerved, but alſo it is duly adjuſted to the denſity of the earth and waters, and to the make and temper of our bodies, and of all other things here below. Had we been much nearer the Sun, our world would have been burnt up, and waſted; the waters, in the firſt place, would have all been turned into vapours, and dried up; vegetation have ſoon ceaſed, and all things would have ſoon been waſted, if not burnt and conſumed. Or had we been not at ſo very great a diſtance, but only a little nearer the Sun, than now we are, ſuppoſe a few thouſand of miles, ſtill the heat would be as the ſquare of the * diſtance; and conſequently too great, if not for the polar, yet for the æquatorial parts. And on the contrary, had we been ſet at a greater diſtance from the Sun, ſo would the Sun's heat have been abated, in proportion to the ſquare of that diſtance. And in this caſe, if the diſtance had been very great, we and all things muſt have been perpetually frozen up; or if it had been not ſo great, the world would have ſuffered by cold, the polar at leaſt, if the æquatorial parts could have eſcaped.

And in this caſe, when our globe ſhould thus be parched up with everlaſting heat, or be everlaſtingly frozen with exceſſive cold; inſtead of an habitable, pleaſant, and comfortable world, it muſt become a deſart, a place of irkſomeneſs, miſery, and everlaſting puniſhment. But the great Creator having ſo wiſely, and indulgently, ordered the diſtance between the earth and Sun, the Sun's

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* Newton, Princip. p. 466.

light and heat are incomparably accommodated to the ſtate and temper of all things here below, and our world is well fitted for habitation, well provided with every thing that may miniſter to the ſupport, the comfort and pleaſure of its inhabitants. By thoſe indulgent rays, all things are enlightened, and we, and all the reſt of the animal kingdom, are enabled to diſpatch our buſineſs, to ſeek and provide our food, and to paſs from place to place, as our occaſion or pleaſures lead us. By its cheriſhing beams all things are warmed and comforted, vapours, in ſome meaſure, made to riſe for the forming of clouds and rain; trees and plants are enabled thereby to put on their verdure and gaiety, and to yield us the benefit and pleaſure of their grain and fruit. By the preſence of this great fountain of light and heat, we, and even nature too, is awake and excited; and by its abſence, grows torpid and dull: Its abſence, by night, diſpoſes us to reſt and ſleep; and even vegetables too ſhut up their flowers then *, and in a manner betake themſelves to reſt: And its abſence in winter, how doth it change the whole face of nature, diveſt vegetables of their gay attire, force animals to places of ſhelter and ſafeguard,

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* See Phyſico-Theol. book 10. note 14.

and give an aſpect of melancholy and horror to all things!

Thus it is manifeſt how wiſely and indulgently the great Creator hath provided for the good of our planet, by ſo critically adjuſting its poſition to, and its diſtance from the Sun, to the ſtate and temper of it, and all things thereon. And although the reſt of the planets encompaſſing the Sun, are ſome of them farther from it, yet there is no great queſtion to be made, but the ſame wiſe Contriver hath made as good a proviſion for them as for us, either by contempering their denſity to their diſtance from the Sun, or by ſome other the wiſeſt and beſt courſe; as we have very juſt reaſon to ſuſpect from that grand and ſolemn apparatus I ſhall ſpeak of, of ſecondary planets. Which leads me to conſider the proviſions made for the ſupply of the Sun's abſence, and its greater diſtance.

## CHAP. III.

### *The Neceſſity of* LIGHT, *and the Proviſion for it by the Atmoſphere.*

BEFORE I come to the other planets, it will be convenient to conſider how the Sun's abſence is ſupplied here upon the earth, as alſo, probably, how it is ſupplied in her concomitant the Moon.

And firſt as to the earth. Of ſuch abſolute neceſſity is light, (not to mention heat), that our world could not well be in the leaſt utterly without it, becauſe if there ſhould be utter, abſolute darkneſs, (beſides the great inconveniencies it might bring to vegetables, minerals, and every other ſuch like part of the creation, beſides this I ſay) it would certainly put animals under an abſolute incapacity of performing their moſt neceſſary buſineſs, and acting in that office which the divine Providence hath appointed them, although of greateſt uſe to themſelves, or the reſt of the world. Men, for inſtance, whoſe buſineſs and occaſions oftentimes neceſſitate them to borrow a part of the night; and all other animals, particularly ſuch whoſe ſafety, or temper, or conſtitution of parts (as of their eye, for inſtance, or ſome other parts) confine them to their dens, and places of retirement and reſt by day, and are therefore in courſe compelled to ſeek their food, and wander about on their moſt neceſſary occaſions of life by night; all theſe, I ſay, would at once be cut off from one of the grand benefits of life, from acting that part they bear in the creation, during ſuch time as they ſhould be put into abſolute darkneſs. But to prevent this, the infinitely wiſe Contriver of the world hath made divers admirable proviſions, both in our own, and the other planets too. One proviſion which he hath made in our own globe, and I might add that of the Moon alſo, is by encompaſſing both with an atmoſphere *, which among other grand uſes,

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* Mr Huygens in his Coſmotheor. p. 115. concludes the Moon to have no air or atmoſphere, becauſe we ſee its limb ſo clearly and accurately defined, and becauſe he thought there are no ſeas or rivers in the Moon. But he was miſtaken both in his concluſion and part of his premiſes. For in the ſolar eclipſe, May 1. 1706. which in Switzerland was total, they could manifeſtly perceive the Moon's atmoſphere, as may be ſeen in the accounts given in Philoſ. Tranſ. No. 306. And ſince that, in the laſt total eclipſe of the Sun, April 22. 1715. the Moon's atmoſphere was very diſcernible, appearing in the form of a curious ring of vapours encompaſſing the Moon all the time of total darkneſs. Of which ſee the accounts, in the Philoſ. Tranſ. and Mr Whiſton's.

miniſters very much to the propagation of light, partly by reflecting the rays of light to our eyes, and partly refracting them, ſo as to make them viſible and uſeful to us, when otherwiſe they would not appear. Hence that whiteneſs and brightneſs † obſervable in the air by day; and hence the twilight, when the Sun is hidden under the horizon. The like to which is obſervable in the Moon alſo, in that ſecondary, ruſty light, which is ſeen in her eclipſes, and before and after her quarters.

## CHAP. IV.

### *The great Uſefulneſs of the Moon, and the mutual beneficial Returns which the Globes make to one another.*

HAVING ſhewn the abſolute neceſſity of light, and the ſupply thereof by atmoſpheres; let us next ſpeak of the principal proviſion made for that, and for ſupplying the Sun's abſence, and that is by the Moon and ſtars, which as Moſes ſaith *, *rule the night*, as the *greater light*, the Sun, *doth rule the day.* What influences theſe celeſtial bodies may have here below, on the bodies of men, and other animals, or among vegetables, foſſils, or in any of the grand works of nature, is hard to determine, although vainly pretended unto by the judicial Aſtrologers: but yet ſome things there are, whoſe periods and criſes ſo ſtrictly obſerve the courſes of the Sun, eſpecially of the Moon, that on the other hand, it is hard to deny the influences of theſe bodies here below. The tides particularly have all along ſo conſtantly obſerved the courſes of the Moon, that in all ages they have been ſuſpected to be cauſed and governed by that planet: and if the ſtories of Pliny *, Ariſtotle, and others of the ancients be true, it is by her influence, that the bodies of oyſters and other ſhellfiſh are increaſed and diminiſhed; that the maſs of man's blood is ſo alſo; that the humours are reſolved and attracted, that the dead bodies of beaſts are corrupted; that all animals expire at the time of ebb, particularly man; that the ſea purgeth itſelf of filth every full moon, which gave occaſion to the fable of the Sun's having his ſtable about *Meſſina* and *Milazzo;* and divers other ſuch like conceits, which thoſe authors name, too many and too improbable, to deſerve to be reckoned up in this place.

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† See Phyſico-Theol. book ii. chap. 1. note 12.

* Gen. i. 16.

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* Plin. Nat. Hiſt. lib. ii. cap. 41. 98. 99. 101.

But whatever influences the Moon may have upon things here below, whatever her concern may be in any tranſaction of nature, or any other office of the creation, it is however very certain, that her light, eclipſes, monthly revolutions, and latitude, or vagations towards our poles, are of great uſe to us.

By her *light*, to which I may add that of the *ſtars*, we and the reſt of the creatures are able to protract our day at pleaſure, to go hither and thither as our occaſions call, and to diſpatch many of our affairs by night, or to betake ourſelves to repoſe and reſt, to which, according to Pliny *, the Moon doth naturally incline us.

As to the eclipſes, whether of Sun or Moon, they have their excellent uſes too. The aſtronomer applies them to conſiderable ſervices in his way; and the geographer makes them no leſs uſeful in his; the chronologer is enabled by them to amend his accounts of time, even of the moſt ancient days, and ſo down through all ages; and the mariner too can make them ſerviceable to his purpoſe, to diſcover his longitude, to correct his account at ſea, and thereby make himſelf more ſecure and ſafe in the untrodden paths of the deep.

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* Ferunt Lunae foemineum ac molle ſidus, atque nocturnum, ſolvere humorum, et trahere, non auferre. Id manifeſtum eſſe quod——Somno ſopitis ſorporem contractum in caput revocet. Plin. lib. 2. cap. 101.

So for the monthly revolutions of the Moon, beſides the uſes they have in the daily variations of the tides, and perhaps cauſing ſome ſuch revolutions too in the humours and bodies of animals, and in the works of nature; beſides this, I ſay, they are manifeſtly of excellent uſe in the diviſions of time, in meaſuring out our months, as the Sun doth our days and years, according to that appointment of the Creator, Gen. i. 14. “And God ſaid, Let there be lights in the firmament of the heaven, to divide the day from the night: and let them be for ſigns, and for ſeaſons, and for days and years.”

And laſtly, as to the lunar latitude, or progreſſes towards our poles, beſides the uſe hereof to the preventing the too frequent eclipſes of the Sun and Moon, thoſe vagations are of great uſe to the polar parts of the world, in affording them a longer, as alſo a ſtronger and better light, than if the rays fell more oblique: which muſt needs be a very great comfort, and wonderful ſervice to the inhabitants of thoſe forlorn parts, in their long and tedious nights of ſome days, yea, ſome months length:

to men, to enable them to diſpatch ſuch of their affairs as are of perpetual and conſtant neceſſity; and to other animals of the air, land, or waters, to enable them, with great eaſe and pleaſure, to get their food, and paſs where their pleaſure leads them.

Thus the great Creator hath made the Moon to be of admirable uſe to our earth. And ſo wiſely hath he contrived his works, that they are mutually ſerviceable to one another, ſo that what good ſervices one doth, the other as readily returneth again. Thus as the Moon to us, ſo the earth is with great reaſon concluded by the philoſophers, to be a Moon to the Moon; not indeed a ſecondary planet, moving periodically about her, but ſuch a planet, as reflects the light of the Sun to her, and perhaps makes ſuch like returns of influx, as I ſaid the earth receives from her. For it is not to be doubted, if the earth reflects light, gravitates to the Moon, as well as the Moon to the earth, (which is highly probable), but that there is a mutual intercourſe, and return of their influences and good offices. And this is ſtill more probable from the likeneſs diſcernible between the earth and the Moon, which is a ſtrong preſumption that the Moon may have the ſame occaſions for the earth, as the earth for her. For that ſhe is an opake body, and that her ſurface is covered in ſome meaſure with hills and vallies, is manifeſt beyond all doubt to our eye, as I ſaid before *: And that ſhe hath an atmoſphere, is what hath been not long ſince diſcovered †: And that there are large oceans and collections of water, is what I have before made probable ‡. And therefore agreeing thus in conſtitution and make, their occaſions for, and influences upon each other, are in all probability mutual, and much the ſame.

And after this manner the infinitely wiſe Contriver of the univerſe ſeems to have tranſacted throughout that immenſe ſpace, by making all the ſeveral globes uſeful to one another. Thus all the planets of our ſolar ſyſtem are of conſiderable uſe to us, all of them reflect light unto us, and ſome of them a light ſo bright and ſtrong, (as particularly Venus and Jupiter), that they are a good ſupply of the Moon's abſence in the night, as well as the Sun's. Nay the very ſecondaries (which I ſhall ſhew are of greateſt uſe to their primary planets) have their uſes too amongſt us; not only as being evident demonſtrations of the great works of God, but alſo in miniſtering to the diſcovery of the longitude of the moſt diſtant places upon the earth. So for the fixt-ſtars, which I have before ſhewn to be (probably) ſo many Suns, miniſtering to as many ſyſtems of the planets; it is certain they are of great uſe to us in ſupplying the abſence of the Sun and Moon by night. And there is no great doubt to be made, but that like returns are made to them and their ſyſtems by our Sun. So that here we have an admirable œconomy obſervable throughout all the viſible regions of the univerſe, in the mutual aſſiſtances, and returns, which one globe affords the other, even at the greateſt diſtance.

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* See page 114. the note.

† See page 122. note.

‡ Book v. chap. 4. note *a*. as alſo the preface.

## CHAP. V.

### *Of the Moons, or ſecondary Planets in general, which are obſerved about ſome of the Primary Planets.*

HAVING taken a view of the methods which are uſed for the accommodating the earth with light and heat, let us caſt our eye to the reſt of our Solar Syſtem, and examine whether any thing of the like kind is to be found there. And here we ſhall find a no leſs admirable ſcene of the great Creator's care and wiſdom, than we diſcovered in the earth and Moon. In Mars indeed, we can diſcern a great ſimilitude with the earth, in its opacity and ſpots, but we have not yet been able to perceive any attendance of Moons, as in the other ſuperiour planets; not ſo much probably becauſe there are none, but becauſe they are ſmall, or they reflect a weak light, and are at a great diſtance from us: and as for Venus and Mercury, there may be no occaſion for any attendants, by reaſon of their proximity to the Sun. But in the two higheſt or more diſtant planets, Jupiter and Saturn, we have a very noble, and entertaining ſcene of the CREATOR's glory. For whereas thoſe two planets are at a much greater diſtance, than any of the other planets, from their fountain of light and heat, the Sun; and as conſequently their heat and light are abated in proportion to the ſquare of their diſtances; ſo to make them amends, they are ſurrounded with a grand retinue of ſecondary planets, or Moons; Jupiter with four, Saturn with five, as it is imagined, and probably more *.

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* Mr Huygens in his Coſmotheor. p. 99. gives this account of the diſcovery of the ſatellites of Jupiter and Saturn, That

And an admirable remedy this is, not only for the great diſtance of theſe two planets from the Sun, but alſo for the tardity of the periodic motion in their reſpective orbits. For whereas Saturn revolves round the Sun but once in near thirty years, and Jupiter but once in near twelve, it comes to paſs that the places near the two poles of thoſe planets, have a night of near fifteen years in Saturn, and ſix in Jupiter, ſuppoſing their axes inclined to the planes of their orbits, as it is in our own globe. But ſuppoſing (as it is imagined) that their axes are not ſo much inclined, and that their days and nights, their winters and ſummers, are nearly equal; in this reſpect, the caſe would be worſe than in the long nights, in the other caſe: but in both caſes, the polar parts of both thoſe planets would be diſmal regions of darkneſs, when ſo long detained from the kindly

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it is well known the diſcovery of the circumjovials is owing to Galilaeo; that the brighteſt, and the outermoſt circumſaturnial he happened to ſee with a 21 foot glaſs in the year 1665; that the reſt are owing to Caſſini, who firſt ſaw them with a glaſs of Campani's grinding, of 36 feet, and afterwards with one of as many feet above an hundred. That the third and fifth, Caſſini ſhewed him in 1672, and afterwards oftner. That Caſſini acquainted him, by letter afterwards, with his diſcovery of the firſt and ſecond in 1684. That the two laſt are not eaſily diſcerned, and he cannot ſay he ever ſaw them. That beſides theſe five, he ſuſpects there may be one or more lie concealed. Of which ſee chap. vii. following.

viſits of the Sun. But an admirable remedy is found, and a glorious ſcene of the great CREATOR's works appears therein, as will be manifeſt by conſidering particulars in each of thoſe two ſuperiour planets.

## CHAP. VI.

### *Of* JUPITER's *Moons, Days, and Seaſons.*

IN ſpeaking concerning the ſuperiour planets in particular, I ſhall begin with Jupiter. The diſtance of this planet from the Sun, is reckoned to be 343 millions of miles farther from the Sun than we are; and by that means, the Sun's light and heat are 27 times leſs there than with us, and its apparent diameter, five times leſs*. And conſidering how vaſt a globe Jupiter is, having its ſuperficies 100 times, yea, (according to Mr Huygens's computations) 400 times bigger than that of the earth; in this caſe, what a vaſt track of that globe muſt needs lie in profound darkneſs and deſolation, had no remedy been provided! But there are divers provided. One is by the frequent rotations of Jupiter round his own axis; which being performed in leſs than 10 hours, it comes to paſs, that what is wanting in the ſtrength and degree of light and heat, is compenſated by the frequent returns thereof.

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* Gregorii Aſtron. lib. vi. Prop. 5. Mr Huygens makes the light and heat but 25 times leſs, and the apparent diameter 5 times. Coſmoth. p. 103.

The other remedy is by the increaſe of the number of Moons about Jupiter, who is attended (as I ſaid) with four, as we who are nearer the Sun, are with one. Concerning which theſe four things are remarkable.

1. Their bulk, which in all probability, is not in any of them leſs than our earth, as the moſt ingenious Mr Huygens concludes * from their ſhade upon Jupiter's diſk. By which partly it is that,

2. They reflect ſo ſtrong, briſk, and vivid a light, as appears very illuſtrious, and entertaining, even to us at ſo great a diſtance from it: Which cannot but be very pleaſing and comfortable to that planet: beſides the no leſs beneficial and friendly influences conveyed therewith at the ſame time.

3. Their due diſtances from Jupiter, and from one another; and their agreeable periodic revolutions, which I have formerly obſerved † to be

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* Coſmotheor. p. 101.

† Book iv. chap. 4.

in the moſt exact mathematical proportions. By the firſt of theſe, thoſe ſatellites eſcape all diſagreeable concourſes, and violent oppoſitions, and, in the moſt kindly manner, ſend their influx to the planet they wait upon: And by the latter, they are perpetually carrying about their light, and other benefits from place to place. For by the motion of the innermoſt, round once in leſs than two days; of the next in about 3 ½ days; of the third in ſomewhat above a week; and of the outermoſt in near 17 days: by theſe means, I ſay, it happens very ſeldom that any part of Jupiter is at any time without the preſence and attendance of one or more of thoſe ſatellites; but one is viſiting one part, whilſt another is attending another, and another another part, and Jupiter himſelf making ſpeedy returns and revolutions all the while.

4. The laſt thing remarkable, is the latitudes of Jupiter's Moons, or their progreſſes towards his poles, which are in a due proportion to their diſtances and periods: as I have before ſhewn, book iv. chap. 5.

And as the latitudes of theſe ſatellites differ, according to their diſtances and periods; ſo another remarkable thing therein, is, that they ſhift their latitudes in longer or ſhorter times, according as their latitudes, or vagations towards the polar parts of Jupiter, are greater or leſſer. By which means, ſome are making their progreſſes towards Jupiter's poles one way, whilſt ſome are wandering the other way, and ſome are ſtaying there a longer time, and ſome a leſſer and leſſer time. By which quadruple variety of latitudes, and perpetual changes of it, it comes to paſs, that thoſe large tracks towards the polar parts of that vaſt planet, have their due ſhare in the light and kindly ſervice of its four Moons, and are ſeldom or never deprived of them.

## CHAP. VII.

## *Of* SATURN'S *Moons, Ring, Days, and Seaſons.*

HAVING ſeen the admirable proviſions made for the remedying Jupiter's great diſtance from the Sun; let us, in the laſt place, take a view of Saturn; which is above 200 millions of Engliſh miles farther from the Sun than Jupiter, and near 700 millions of miles farther than is our earth. And here our glaſſes, as imperfect as they are, have diſcovered ſo ſurpriſing an apparatus, that muſt needs ſtrike every one that views it with wonder and amazement.

For, in the firſt place, inſtead of four ſatellites or moons, as Jupiter hath, Saturn hath five, and probably more. Three of theſe I myſelf have ſeen with Mr Huygens' 120 foot glaſs; but for want of a pole of ſufficient height to mount the glaſs high enough, I am not ſure I have ſeen any more. And beſides thoſe five, which others have ſeen; there is great reaſon to conclude there is a ſixth lying between the two outermoſt, there being a larger ſpace between them, than is in proportion to what is found amongſt the reſt. And it is not improbable but that there are others alſo lying beyond the fifth, or the outermoſt, but become inviſible at ſo great a diſtance from us by means of ſome obſcurity, ſuch as is obſervable in the outermoſt itſelf, which is never to be ſeen by us, but in the weſtern part of its orbit, as Mr Huygens well obſerves *.

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* The reaſon why Saturn's fifth ſatellite appears not on the eaſtern, but weſtern part of its orbit, Mr Huygens very ſagaciouſly, like himſelf, conjectures to be, becauſe this ſatellite, as the Moon doth to the earth, always turns one and the ſame ſide to Saturn, and becauſe this ſatellite hath, he imagines, only one part of its ſurface clear, and the greateſt part obſcure, and not able to reflect ſufficient light to us; therefore all the time that obſcure part is turned towards us, (which is whilſt the ſatellite is in the eaſtern parts of its orbit), it diſappears: but in the weſtern parts it appears, becauſe the bright ſides lie towards us, Coſmoth. p. 118.

Theſe ſatellites we may reaſonably conclude to be of a prodigious bulk, for the reflecting of light, and for their other miniſtrations of Saturn, becauſe otherwiſe they could not be ſeen at ſo great a diſtance as the earth; and particularly one of them † is of that magnitude, and its light ſo briſk and vivid, that it appears very illuſtrious through our longer glaſſes, and may be diſcerned with our ſhorter.

As to the diſtances, the periods, and latitudes of thoſe ſatellites, they being conſentaneous to what I have already taken notice of in Jupiter, I ſhall not inſiſt upon them, but paſs to another proviſion made for the great diſtance of that planet; which is a thing ſo ſingular to Saturn, ſo unuſual in all the reſt of the creation, and ſo amazing, that it is an evident and noble demonſtration of the great CREATOR's art and care; and that is Saturn's *ring*. Concerning which theſe things are obſervable.

1. The prodigious ſize of it, its great breadth and vaſt compaſs; this we may make a judgement of, by comparing it with Saturn himſelf. And ſuppoſing the diameter of Saturn to be, as is be-

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† It is the fourth ſatellite, or outermoſt but one, called from its firſt diſcoverer, the Huygenian Satellite, that is ſo viſible.

fore determined, 93451 Engliſh miles, the diameter of his ring will be 210265 ſuch miles, and its breadth about 29200 *; an amazing arch to an eye placed in that planet.

2. The due and convenient diſtance of it from Saturn itſelf; not cloſely adhering to it, becauſe that would annoy a large portion of Saturn's globe, by depriving it of the Sun's rays, but environing it about the diſtance of its breadth; by which means the Sun's light and heat are permitted to enter between the planet and its ring, whilſt other rays are, at the ſame time, reflected upon the planet by the ring.

3. The thickneſs of the ring, which is hardly, if at all perceivable by us; which is as great a benefit, as its edging ſhade would be an annoyance, was the ring thick.

4. Its ſmoothneſs and aptitude to reflect light and heat † is a wonderful convenience in it. Was it full of mountains and vallies, and I may add waters too, as in our earth, and probably the Moon likewiſe, the reflection would be too weak

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* Mr Huygens, in his Syſtema Sat. p. 109. determines the diameter of Saturn's ring to the diameter of Saturn, to be as 9 to 4; and the breadth of the ring, and diſtance of the ring from Saturn's body, to be nearly equal, and accordingly theſe numbers are defined here.

† See Huygen. Syſt. Saturn. p. 70.

to render the ring viſible unto us, at ſo great a diſtance as we are; but perceiving its light to be ſo lively and ſtrong, as to render both itſelf, and Saturn very illuſtrious, it is a demonſtration of the aptitude of its ſtructure, and ſmoothneſs for the reflection of light and heat to the planet it ſerves.

5. As the periodical revolutions of the earth are an excellent and providential contrivance, for thoſe uſeful and neceſſary mutations we have of the ſeaſons of the year, ſo no doubt but the ſame benefits accrue to thoſe revolutions, which Saturn hath about the Sun. It is viſible, that as Saturn changes its place in its orbit, ſo its ring receives a variety of aſpects * not only with reſpect to us, but to the Sun. Thus in one part of the orbit it appears with a † large ellipſis, ſo as to

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* Every 14 or 15 years Saturn's ring hath the ſame face; appearing at one time with large open anſae, at another time with no ring at all. Which appearance is obtained by gentle progreſſes from the one to the other face. As, if the anſae are the largeſt, they gradually diminiſh, until no anſae or apertures are to be ſeen in the ring, and at laſt no ring at all alſo. See Fig. 8.

† This Mr Huygens ſhews, is when Saturn is 20 and one half degrees in Gemini and Sagitary. This was the appearance it had in April 1708, and which it will again receive at the end of 1722; only with this difference, that whereas the ring traverſed the upper or northerly part of Saturn's diſk in 1708, it doth now, and will for ſome years to come, traverſe the lower or ſoutherly part thereof, as is repreſented in Fig. 7.

exhibit a large ſpace between it and Saturn: in another part, with a leſſer, and ſo with a leſſer ellipſis, and ſometimes as only a ſlender ſtrait line, and ſometimes it is not viſible at all ‡; alſo ſometimes one ſide of the ring is enlightened, and reflects light towards one part of Saturn, ſometimes the other enlightens another part: and there is no doubt, but that as our earth has its ſeaſons, according to its poſition to the Sun, and its periodical motion in its orbit; ſo Saturn throughout his period, hath his ſeaſons, according unto his poſition to the Sun, and the various reflections of the ring upon the ſeveral parts of his globe ‖.

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‡ Mr Huygens ſhews, that for about ſix months before and after Saturn's being in 20 and a half degrees of Virgo and Piſces, the ring is not viſible, but Saturn appears round. Syſt. Satur. p. 59. 74. *etc.* And accordingly at this very time, there is no appearance of the ring, only a ſmall narrow liſt or belt croſſeth the middle of Saturn's diſk, a colour ſomewhat different from the reſt of Saturn's face, and in the place where the ring ſhould be. This appearance of Saturn is repreſented in Fig. 8. which is the appearance he had through a very good 34 foot glaſs, at the latter end of Octob. and beginning of Nov. this preſent year 1714. But a little before this, *viz.* on Sept. 26. I could through an 126 foot glaſs diſcern the narrow ends of the ring on each ſide Saturn. A repreſentation of which I have given in Fig. 9.

‖ There is very great reaſon to imagine this doth certainly happen in Saturn, becauſe, as Mr Huygens obſerves, Saturn appears ſometimes more ſplendid than at other times. "Ita "ſemper, ſaith he, quo propius verſus Cancri et Capricorni "ſigna acceſſerit, eo majorem aut certe ſplendidiorem, etiam "abſque teleſcopio appariturum, quippe annuli ellipſi ſemper "ſe latius pandente." Huygen. Syſt. Saturn. p. 56.

Theſe five things obſervable in Saturn's ring, we have pretty good aſſurance of, from our views through good glaſſes. But there is a

6. Thing I ſhall add as only conjectural, and that is a ſuppoſition that the axis of Saturn * is inclined (and that pretty much alſo) to the plane of its ring, or the plane of its orbit at leaſt; and that he hath a diurnal rotation in ſome certain ſhort ſpace of time. For without theſe two conveniencies, very large tracks of Saturn would ſuffer extremely for want of the Sun. For if Saturn hath no other motion, but that round the Sun in its orb, one part muſt be excluded from the Sun's viſits for 15 years, whilſt the other partakes all the while of them; and one hemiſphere will enjoy the benefit of the ring, whilſt the other is eclipſed by it: and in this caſe the ring would be nearly as prejudicial to the eclipſed part, as it is uſeful to the enlightened. But ſuppoſing Saturn to move round in the ſame, or a ſhorter time than Jupiter, and in a path pretty much inclined to the ring, all parts then of that vaſt planet will have their frequent returns of day and night, of heat and cold. And ſince this is what is diſcernible in the other

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* Mr Huygens determines the inclination of Saturn's axis to the plane of his orbit to be 31 gr. as that of the earth is 23 degrees, Coſmotheor. p. 108.

planets, and is no leſs neceſſary for the benefit and comfort of this, we may reaſonably conclude the thing to be probable, although not diſcernible at Saturn's great diſtance from us.

## CHAP. VIII.

## *The* CONCLUSION.

THUS I have taken a view of the proviſion made for thoſe two grand, and univerſal neceſſaries, light and heat; things, in all probability, no leſs neceſſary for the other globes, than for our own, and things which not only animals cannot ſubſiſt without, but what all things here below ſtand in need of, as well as they. When therefore we actually ſee, and feel thoſe indulgent proviſions, thoſe amazing acts of the great CREATOR; when we have views of their extent into myriads of other the moſt diſtant globes; when (to go no farther) we ſee in our own ſyſtem of the Sun ſuch a prodigious maſs of fire as the Sun is, placed in the centre, to ſcatter away the darkneſs, and to warm and cheriſh us by day, and ſuch a noble retinue of Moons and ſtars, attending and aſſiſting us by night; when we ſee this indulgence, this care of the Creator, extended to all the other planets, and that according to their ſeveral diſtances, they have a proportionate proviſion of the greater number of Moons, and Saturn a ſtupendous ring beſides, to ſupply the decreaſe of light and heat; who can be otherwiſe than amazed at ſuch providential, ſuch uſeful, ſuch well contrived, ſuch ſtately works of God! who can view their glories, and partake of their beneficial influences, and at the ſame time not adore the wiſdom, and praiſe the kindneſs of their CONTRIVER and MAKER! But above all, ſhould there be any found, among rational beings, ſo ſtupid, ſo vile, ſo infatuated with their vices, as to deny theſe works to be God's, and aſcribe them to a neceſſity of nature, or indeed a mere nothing, namely, chance! but ſuch there are to be met with among ourſelves, and ſome ſuch the prophet tells us of, Iſ. v. 11. 12. men that had ſo debauched themſelves with drink, and enervated their minds by pleaſures, that "they "regarded not the work of the Lord, neither "conſidered the operation of his hands." Such perſons led their lives in ſuch a manner, as to wiſh there was no God to call them to account, would then perſuade themſelves there is none; and therefore ſtupidly aſcribe thoſe manifeſt demonſtrations of the infinite power and wiſdom of God, to a mere nothing, rather than to their great Author. But may we not with as good reaſon imagine a lighted candle, a well made culinary fire, flaming beacon, or light-houſe, to be the work of chance, and not of man, as thoſe glories of the heavens not to be the works of God? For it is very certain, that as much wiſdom, art, and power worthy of God, is ſhewn in the lights of the heavens; as there is in thoſe upon the earth, worthy of man, which none can doubt were contrived and made by man. And if from theſe mean contrivances and works of man, we conclude them to be the works of man; why not the grand, the amazing works of the heavens, ſurpaſſing all the wit and power of man, why not theſe, I ſay, the works of ſome Being as much ſuperior to man? According to the argument of Chryſippus, which ſhall conclude this book. "If there be any Being that can effect "thoſe things, which man, although endowed "with reaſon, is not able to effect; that Being is "certainly greater, and ſtronger, and wiſer than "man. But man is not able to make the hea"vens; therefore the Being that did make them, "excels man in art, counſel, prudence, and power."

# BOOK VIII.

## Practical INFERENCES from the foregoing SURVEY.

IN the foregoing ſeven books, having taken a view of what preſents itſelf to us in the Heavens, and ſeen a ſcene of the greateſt grandeur, a work well contrived, admirably adapted, and every way full of magnificence; all that now remains is, to endeavour to make theſe views and conſiderations uſeful to ourſelves. Which I ſhall do in the following chapters.

### CHAP. I.

### *The Exiſtence of* GOD *collected by the Heathens from the Works of the Heavens.*

THE firſt and moſt ready and natural deduction we can make from ſuch a glorious ſcene of workmanſhip, as is before repreſented, is to conſider, *who the great Workman was?*

That the author of all this glorious ſcene of things was God, is ſuch a concluſion, that even the moſt ignorant, and barbarous part of mankind have been able to make from the manifeſt ſignals viſible therein; ſignals ſo plain and concluſive, that Tully's Stoick * cites it as Ariſtotle's opinion, " That if there were ſuch a ſort of people, " that had always lived under the earth, in good " and ſplendid habitations, adorned with imagery " and pictures, and furniſhed with all things " that thoſe accounted happy abound with: " and ſuppoſing that theſe people had never at " any time gone out upon the earth, but only by " report had heard there was ſuch a thing as a " Deity, and a power of the Gods; and that at a " certain time afterwards, the earth ſhould open, " and this people get out of their hidden man" ſions into the places we inhabit: When on the " ſudden they ſhould ſee the earth, the ſeas, and " the heavens, perceive the magnitude of the " clouds, and the force of the winds; behold the " Sun, and its grandeur and beauty; and know " its power in making the day, by diffuſing his " light throughout the whole heavens; and when " the night had overſpread the earth with dark" neſs, they ſhould diſcern the whole heavens

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* De Nat. Deor. lib. ii. cap. 37.

" beſpread and adorned with ſtars, and ſee the " variety of the Moon's phaſes in her increaſe and " decreaſe, together with the riſings, and ſettings, " and the ſtated and immutable courſes of all " theſe throughout all eternity; this people, when " they ſhould ſee all theſe things, would infallibly imagine that there are Gods, and that thoſe " grand works were the works of the Gods." Thus have we the opinion and concluſion of two eminent heathens together, Ariſtotle and Tully's Stoick.

And if the heavens ſo plainly " declare the glory " of God, and the firmament ſheweth his handy-" work*;" if thoſe characters, thoſe impreſſes of the divine hand, are ſo legible, " that their line " is gone out through all the earth, and their " words to the end of the world, ſo that there is " no language, tongue, or ſpeech where their " voice is not heard;" nay, if theſe things are ſuch, that even a ſubterraneous people would, at firſt ſight, conclude them to be God's work; how daring and impudent, how unworthy of a rational being is it, to deny theſe works to God, and aſcribe them to any thing, yea, a mere nothing, as chance is, rather than God? Tully's Stoick laſt mentioned, denieth him to be a man who ſhould do this. His words * are, " Who would ſay he is a man, " who when he ſhould behold the motion of the " heavens to be ſo certain, and the orders of the " ſtars ſo eſtabliſhed, and all things ſo well con- " nected and adapted, together, and deny that " reaſon was here, and ſay theſe things were made " by chance, which are managed with ſuch pro- " found counſel, that with all our wit we are " not able to fathom them? What! ſaith he, " when we ſee a thing moved by ſome certain " device, as a ſphere, the hours, and many things " beſides; we make no doubt but that theſe are " the works of reaſon. And ſo when we ſee the " noble train of the heavens, moved and wheeled " about, with an admirable pace, and in the moſt " conſtant manner, making thoſe anniverſary " changes, ſo neceſſary to the good and preſer- " vation of all things; do we doubt whether " theſe things are done by reaſon, yea, by ſome " more excellent and divine reaſon? For, ſaith " he, ſetting aſide the ſubtilties of diſputation, " we may actually behold with our eyes, in ſome " meaſure, the beauty of thoſe things which we " aſſert are ordered by the divine Providence."

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* Pſalm xix. 1. etc.

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* Cicero de Nat. Deor. lib. ii. cap. 38.

And then he enters into a long detail of particulars of this kind, too many to be named here.

Thus Cicero, throughout whoſe works ſo many paſſages of this nature occur, that it would be endleſs to cite them: And therefore one obſervation that ſhews what his opinion was of the ſenſe of mankind in the matter, ſhall cloſe what he ſaith, and that is in his book *de Legibus* *, where he ſaith, "Among all the tribes of animals, none but man "hath any ſenſe of a God; and among man-"kind, there is no nation ſo ſavage and barba-"rous, which although ignorant of what God it "ought to have, yet well knows it ought to have "one."

And after the ſame manner Seneca †, who inſtanceth in two things, to ſhew the deference we are apt to give the general preſumption and conſent of mankind. One is in the *immortality of the ſoul;* the other is in the "exiſtence of a Deity; which, ſaith he, among other arguments we collect from the innate opinion which all men have of the Gods: for there is no nation in the world ſo void of law and morality, as not to believe but there are ſome Gods." Nay, ſo poſitive he is in this matter, that in another place he expreſsly ſaith,

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* Lib. i. cap. 8.

† Epiſt. 117.

" They lie that ſay, they believe there is no God; for although by day they may affirm ſo to thee, yet by night they are to themſelves conſcious of the contrary." Much more could I cite out of this famous heathen; but one paſſage, relating to the heavens, ſhall ſuffice, and that is in his diſcourſe ſhewing " why evils befal good men, ſeeing there is a divine providence *." He takes it for granted in this diſcourſe, " that there is ſuch a thing as a DIVINE POWER and PROVIDENCE governing the world; and he ſaith, it was needleſs for him to ſhew that ſo great a work (as the world) could not ſtand without ſome ruler; that ſo regular motions of the ſtars could not be the effects of a fortuitous force, and that the impulſes of chance muſt be oftentimes diſturbed and juſtle: That this undiſturbed velocity, which bears the weight of ſo many things, in the earth and ſeas; ſo great a number of heavenly lights, both very illuſtrious, and alſo ſhining by a manifeſt diſpoſal, muſt needs proceed by the direction of ſome eternal law: That this can never be the order of ſtraggling matter; neither is it poſſible for things fortuitouſly and raſhly combined, to depend upon, and manifeſt ſo much art." Divers of which matters he proceeds to inſtance in. Thus Cicero and

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* Quare bonis viris, *etc.* cap. i.

Seneca: To whoſe evidences I might have added many others, particularly a great deal out of Plato, (the divine Plato, the Homer of philoſophers, as he is called by the antients): but it would be needleſs, as well as tedious, ſince theſe two former have given us the ſenſe of mankind, as well as their own opinion in the matter.

## CHAP. II.

### GOD'S PERFECTIONS *demonſtrated by his Works.*

AS God's works have been ſhewn to be manifeſt demonſtrations of his exiſtence; ſo they are no leſs of his perfections, particularly of his infinite power, and wiſdom, and goodneſs; inaſmuch as every workman is known by his work. A palace that ſhould have nothing defective in ſituation, beauty, or convenience, would argue the architect to have been a man of ſagacity, and ſkilful in geometry, arithmetic, optics, and all other mathematical ſciencies, ſerving to make a man a complete architect; yea to have ſome judgement in phyſic and natural philoſophy too. And ſo this glorious ſcene of God's works, the heavens, plainly demonſtrate the Workman's infinite *wiſdom* to contrive, his *omnipotency* to make, and his infinite *goodneſs*, in being ſo indulgent to all the creatures, as to contrive and order all his works for their good. For what leſs than infinite could effect all thoſe grand things, which I have in this diſcourſe ſhewn to be manifeſt in the heavens? What architect could build ſuch vaſt maſſes, and ſuch an innumerable company of them too, as I have ſhewn the heavens do contain? What mathematician could ſo exactly adjuſt their diſtances? What mechanic ſo nicely adapt their motions, ſo well contrive their figures, as in the very beſt manner may ſerve to their own conſervation and benefit, and the convenience of the other globes alſo? What naturaliſt, what philoſopher, could impregnate every globe, with a thing of that abſolute neceſſity to its conſervation, as that of gravity is? What optician, what chymiſt could ever have hit upon ſuch a noble apparatus for light and heat, as the Sun, the Moon, and the ſtars are? could amaſs together ſuch a pile of fire as the Sun is? could appoint ſuch lights as the Moon and other ſecondaries are? None certainly could do theſe things but God.

## CHAP. III.

### *Of* GOD's RELATION *to us, and the Duties reſulting from thence.*

IT appearing from the laſt chapter how great a being the CREATOR is, it is time to conſider what relation he ſtands in to us, and what is due from us to him. His relation to us, is that of CREATOR; and as ſuch, of Conſervator, ſovereign LORD, and Ruler, one that hath an abſolute power over us, and all things belonging to us, that can ſubject us to what laws he ſees fit, and that can reward or puniſh us as we deſerve. And in this caſe, the leaſt we can do, is to revere and fear him at all times, to worſhip and ſerve him with all our power, to comply with his holy will ſincerely and heartily, and to obey him in all things he hath either forbidden, or enjoined. And conſidering alſo how great indulgence and love the CREATOR hath ſhewn in his works throughout the univerſe, it naturally follows, that we ought to be truly thankful to him for his mercy and kindneſs, and to love him for his love and goodneſs.

Theſe kind of concluſions are ſo natural, that the very heathens have in ſome meaſure made them. Thus Cicero's Stoick before cited *, "*Quid vero? hominum ratio non,* etc. What! doth not man's reaſon penetrate as far as even the very heavens? For we alone of all animals have known the riſings, ſettings, and courſes of the ſtars; By mankind it is that day, the month and year, is determined; that the eclipſes of the Sun and Moon are known, and foretold to all futurity; of which luminary they are, how great they will be, and when they are to happen. Which thing the mind contemplating, it receives from hence † the knowledge of the Gods: from whence ariſes piety; to which is joined juſtice, and the other virtues; from which ſprings that bleſſed life, which is equal unto, and like that of the Gods themſelves, and in no reſpect yielding to thoſe celeſtials, except in immortality, which is not neceſſary to happy living. And in his book *de Legibus* ‡, Cicero brings in his collocutor ſaying, *Sit igitur hoc a principio perſuaſum,* etc. *i. e.* Let this be what every member of the commonwealth is fully convinced of from the beginning, that the Gods are

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* De Nat. Deor. lib. ii. cap. 61.

‡ Some read it inſtead of *Accipit ad cognitionem Deorum; Accipit ab his cognitionem Deorum.*

‡ Lib. ii. cap. 7.

Lords and Governors of all things; that whatſoever things are done, they are managed by their influence, rule, and divinity; that they merit a great deal of mankind; and obſerve what every one is, what he doth, what he admits into his mind; with what mind, what piety he cultivates religion; and that they take an account both of the righteous and wicked. For, ſaith he, minds that are endued with theſe principles, will ſcarce ever depart from that opinion that is uſeful and true." And a little after *, one of the laws ariſing from hence he ſaith is, " Let men approach the Gods with purity, let them practiſe piety; for he that doth otherwiſe, God himſelf will be the avenger of." This purity and ſincerity is ſo neceſſary a concomitant of religion and divine worſhip, according to Cicero, that he makes it, in another place, to be that which diſtinguiſhes religion from ſuperſtition, † " *Cultus autem deorum eſt optimus*, etc. But that religion, that worſhip of the Gods is the beſt, the pureſt, the holieſt, and fulleſt of piety, that we always revere and worſhip them with a pure, upright, and undefiled mind and voice. For, ſaith he, not only the philoſophers, but our forefathers, have diſtinguiſhed ſuperſtition from religion; "which he aſſigns the difference of, and then tells us, that the one hath the name of a vice, the other of praiſe."

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* Cap. viii.

† De Nat. Deor. lib. cap. 28.

Thus, as the heathens have, by the light of nature, deduced the exiſtence and attributes of God from his works, and particularly thoſe of the heavens; ſo have they, at the ſame time, collected what the principal duties are which men owe to God, ſo reaſonable, ſo natural, ſo manifeſt they are to all mankind.

## CHAP. IV.

### LACTANTIUS *his Argument againſt the Heathen Gods.*

THE next inference ſhall be one made by the eloquent Lactantius: * "*Argumentum illud quo colligunt univerſa Coeleſtia Deos eſſe*, etc. *i. e.* That argument whereby they conclude the heavenly bodies to be Gods, proveth the contrary: for if therefore they think them to be Gods, becauſe they have ſuch certain and well contrived rational courſes, they err. For from hence it appears that they are not Gods, becauſe they are not able to wander out of thoſe paths that are preſcribed them: Whereas if they were Gods, they would go here and there, and every where, without any compulſion, like as animals upon the earth do; whoſe wills being free, they wander hither and thither, as they liſt, and go whitherſoever their minds carry them.

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* Inſtitut. lib. ii. cap. 5.

Thus Lactantius, with great reaſon, refutes the divinity of the heavenly bodies; which, on the contrary, are ſo far from being Gods, and objects of divine honour and worſhip, that ſome of them have been taken to be places of torment. Thus comets particularly, which muſt needs have a very unequal and uncomfortable temper of heat and cold, by reaſon of their prodigiouſly near approaches to the Sun, and as great receſſes from it. Thus, according to the before commended Sir Iſaac Newton's * computation, the comet 1680, in its perihelion, was above 166 times nearer the Sun than the earth is; and conſequently its heat was then 28000 times greater than that of ſummer: So that a ball of iron as big as the earth heated by it, would hardly become cool in 50000 years. Such a place therefore, if deſigned for habitation, may be imagined to be deſtined rather

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* Principia, p. 466.

for a place of torment, than any other ſort of living.

But above all, the Sun itſelf, the great object of heathen worſhip, is, by ſome of our own learned countrymen, ſuppoſed to be probably the place of hell. Of which Mr Swinden hath written a treatiſe called, "An inquiry into the nature and place of Hell."

## CHAP. V.

### *This* SURVEY *of the Heavens teaches us not to overvalue the World; with Reflections of the Heathen Writers thereupon.*

FROM the conſideration of the prodigious magnitude and multitude of the heavenly bodies, and the far more noble furniture and retinue which ſome of them have more than we, we may learn not to overvalue this world, not to ſet our hearts too much upon it, or upon any of its riches, honours, or pleaſures. For what is all our globe but a point, a trifle to the univerſe! a ball not ſo much as viſible among the greateſt part of the heavens, namely the fixed ſtars. And if magnitude or retinue may dignify a planet, Sa-

Fig 12

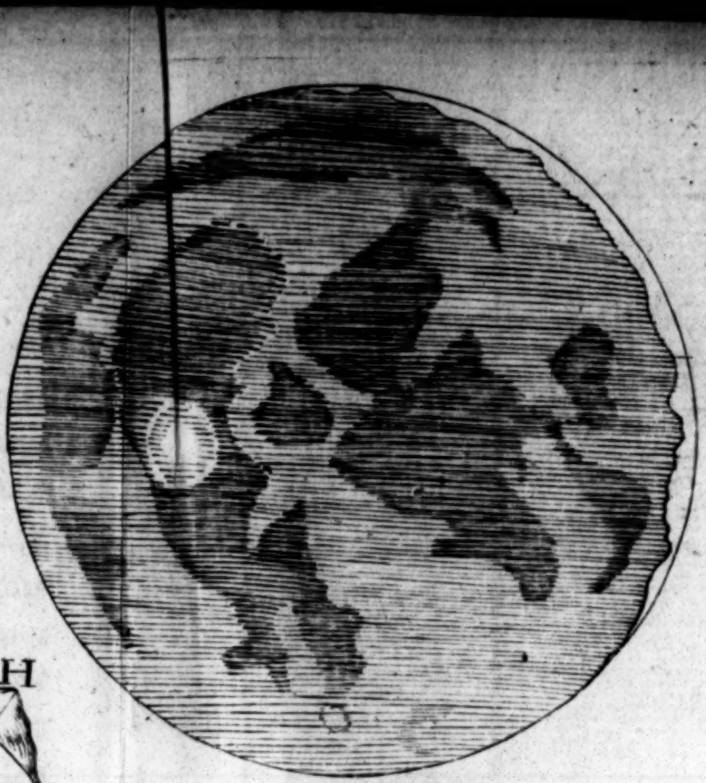

Fig. 6
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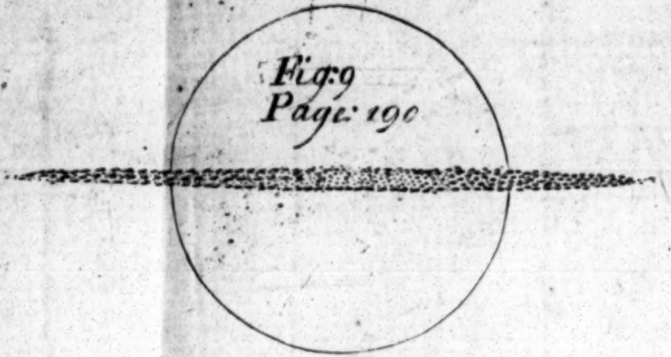

Fig. 9
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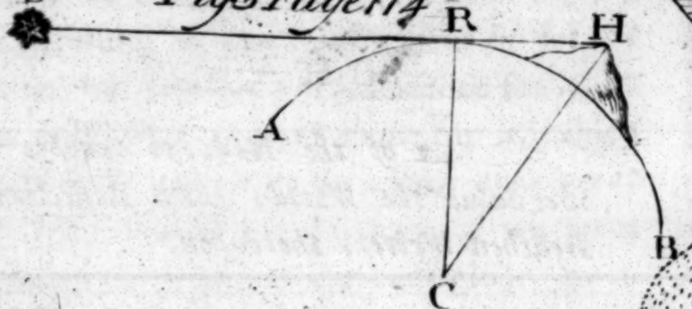

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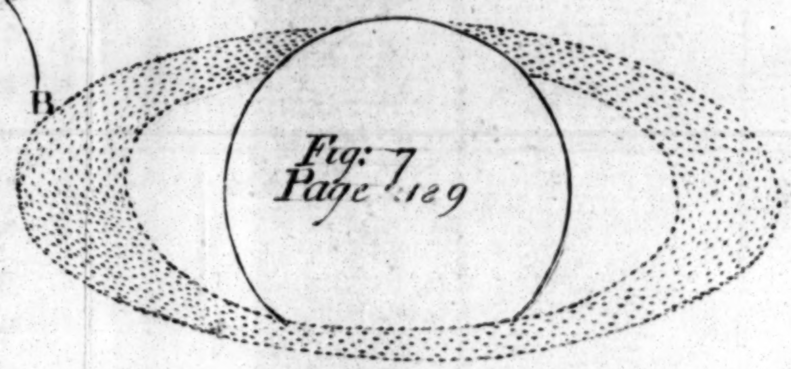

Fig: 7
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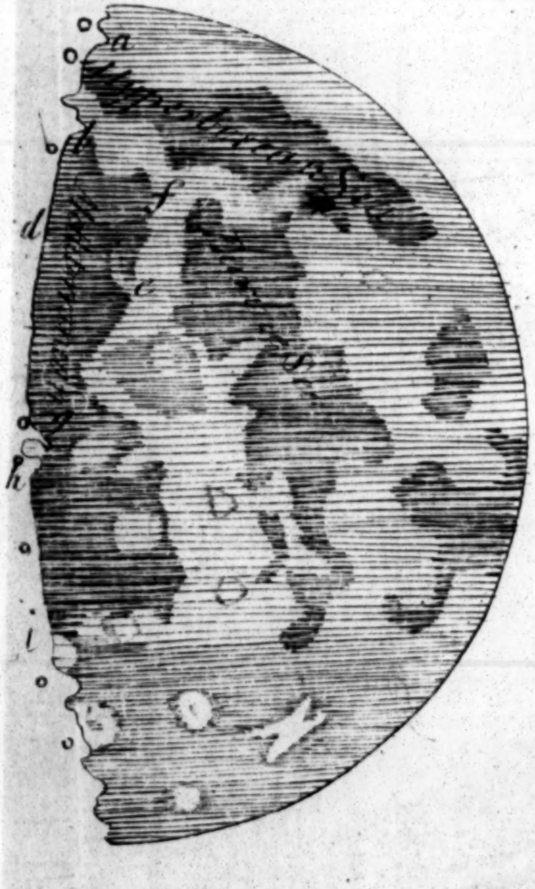

Fig. 11.
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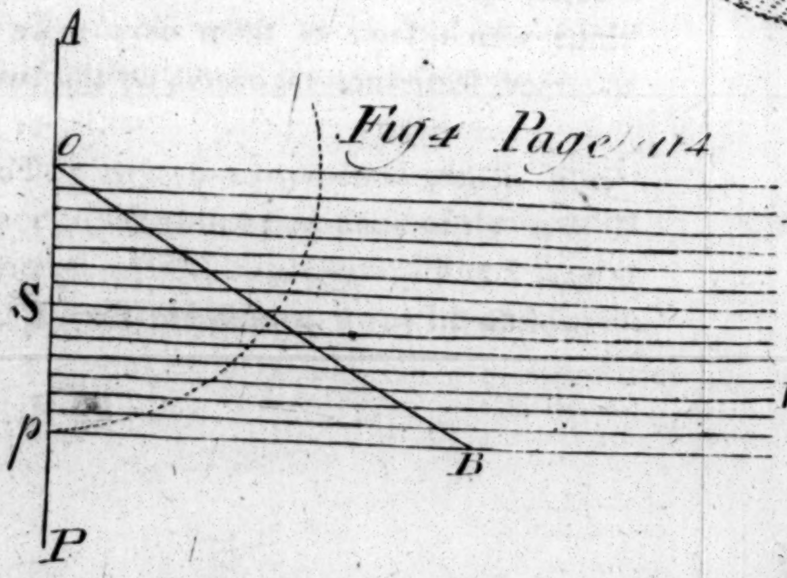

Fig 4 Page 114

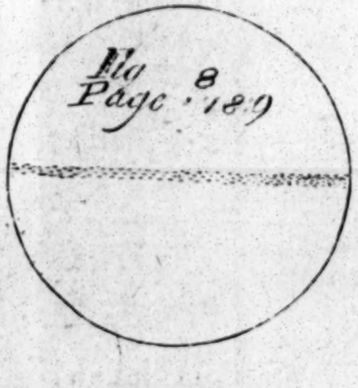

Fig 8
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turn and Jupiter may claim the preference: Or if proximity to the moſt magnificent globe of all the ſyſtem, to the fountain of light and heat, to the centre, can honour and aggrandize a planet, then Mercury and Venus can claim that dignity. If therefore our world be one of the inferiour parts of our ſyſtem, why ſhould we inordinately ſeek and deſire it? But above all, why ſhould we unjuſtly graſp at it, and be guilty of theft or rapine, lying or cheating, or any injuſtice, or ſin for it? Why ſhould we ſacrifice our innocence for it, or part even only with a good name for it, which Solomon ſaith *is rather to be choſen than great riches*[*]? Why ſhould we do thus, if we were ſure of gaining the whole terraqueous globe, much leſs do it for a ſmall pittance of it, as the beſt empire in the world is? For as our bleſſed Saviour argues, Matth. xvi. 26. *What is a man profited, if he ſhould gain the whole world, and loſe his own ſoul? or what ſhall a man give in exchange for his ſoul?*"

But paſſing over the arguments which Chriſtianity ſuggeſts, let us ſee how ſome of the heathen writers deſcant upon this ſubject. Pliny [†] is very pathetical in his reflections, when he had ſhewn what little portions of the earth were left for us, and what large tracks were rendered (as he thought) uſeleſs, the frigid zones being frozen up with exceſſive cold, and torrid zone being burnt up (as the opinion then was) with an exceſſive heat, and other parts drowned by the ſea, lakes and rivers, and others covered with large woods, deſarts, or barren mountains: he then exclaims thus. *Hae tot portiones terrae*, etc. *i. e.* Theſe little parcels of land which are left for our habitation; yea, as many have taught, this point of the world, (for no other is the earth in reſpect of the univerſe), this is the matter, this the ſeat of our glory: here it is we bear our honours; here we exerciſe our authority; here we covet riches; here we begin our civil wars, and ſoften the earth with mutual ſlaughters."

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[*] Prov. xxii. 1.

[†] Nat. Hiſt. lib. ii. cap. 68.

And then having ſhewn how by fraud and violence men ſtrive to enlarge their eſtates, ſaith he, "What a little part of thoſe lands doth he enjoy? And when he hath augmented them even to the meaſure of his avarice, what a poor pittance is it that his dead body at laſt poſſeſſeth?" Thus Pliny. And after the ſame manner Seneca reflects upon the matter *, when he ſhews how virtue tends to make a man completely happy; among other things, by preparing him for the ſociety of God, by enabling the mind to ſoar above the things here below, and to make him laugh at the coſtly pavements of the rich, yea, the whole earth with all its wealth. " *Nec enim poteſt*, ſaith he, *ante contemnere porticus*, etc. *i. e.* " A man can never be able to ſlight the ſtately piazzas, the noble roof ſhining with ivory, the curiouſly clipped woods, and the pleaſant rivulets conveyed to the houſes, until he hath ſurveyed the whole world, and ſpying from above our little globe of earth, covered in a great meaſure by the ſea; and where it is not, is far and near ſqualid, and either parched with heat, or frozen with cold, he ſaith to himſelf, Is this that point, which by fire and ſword is divided among ſo many nations? O how ridiculous are the bounds of mortals! The Iſter bounds the Dacians, the Strymon the Thracians, Euphrates the Parthians, the Danube parteth the Sarmatians and Romans, the Rhine gives bounds to Germany, the Pyrenees to France and Spain, and between Ægypt and Æthiopia lie the vaſt uncultivated ſandy deſarts. If any could give human underſtanding to ants, would not they too divide their moll-hills into divers provinces? And when thou lifteſt up thyſelf in thy truly great province, and ſhall ſee the armed hoſts paſſing here, and lying there, as if ſome great matter was to be acted, conſider that this is no more than the running of ants in a mole-hill. For what difference between them and us, but only the meaſure of a little body? That is but a point in which thou saileſt, in which thou wageſt war, in which thou diſpoſeſt of kingdoms. But above there are vaſt ſpaces, to whoſe poſſeſſion the mind is admitted, provided it brings but little of the body along with it, that it is purged of every vile thing, and that it is nimble and free, and content with ſmall matters." And ſo he goes on to ſhew, that when the mind is once arrived to thoſe celeſtial regions, how it comes to its proper habitation; is delivered from its bounds; hath this argument of its divinity, that divine things delight and pleaſe it, and is converſant with them as its own; that it can ſecurely behold the riſings and ſettings and various courſes of the ſtars; that it curiouſly pries into all thoſe matters, as nearly appertaining to itſelf; that then it contemns the narrow bounds of its former habitation, it being but a trifling ſpace, of a few days journey, from the utmoſt limits of Spain to the very Indies; whereas the celeſtial regions afford a path for the wandering of the ſwifteſt ſtar for 30 years, without any reſiſtance; in which regions he tells us the mind arrives to the knowledge of thoſe things laſt, which it had before long inquired after, and there begins to know God. Thus Seneca; which ſhall ſuffice for this third inference.

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* Nat. Quaeſt. lib. Praef.

## CHAP. VI.

### *That we ſhould aſpire after the heavenly State.*

I ſhall only deduce one thing more from my preceding view of the heavens, and that is, to aſpire after the heavenly ſtate, *to ſeek the things that are above.* We are naturally pleaſed with new things; we take great pains, undergo dangerous voyages, to view other countries: with great delight we hear of new diſcoveries in the heavens, and view thoſe glorious bodies with great pleaſure through our glaſſes. With what pleaſure then ſhall departed happy ſouls ſurvey the moſt diſtant regions of the univerſe, and view all thoſe glorious globes thereof, and their noble appendages with a nearer view? Only let us take eſpecial care to "ſet our affections on things above;" to be "ſpiritually, not carnally minded;" and ſo to "run the race which Chriſt hath ſet before us," that we may arrive to that place which he hath prepared for his faithful ſervants, that he may "receive us unto himſelf, that where he is, there we may be alſo; in whoſe preſence is fulneſs of joy, and at whoſe right hand are pleaſures for evermore."

THE END.

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